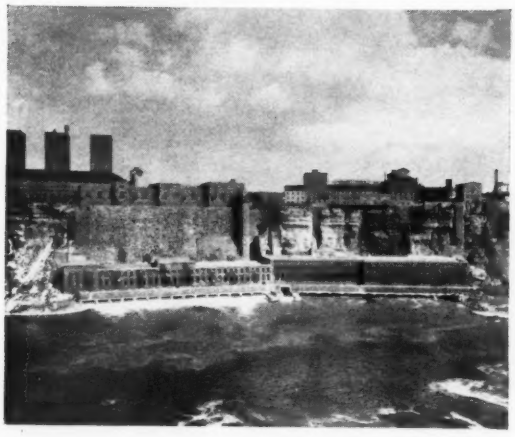
EDISON ELECTRIC INSTITUTE BULLETIN



VOLUME I JULY 1933 NUMBER 4

STATISTICAL DATA OF THE ELECTRIC LIGHT AND POWER INDUSTRY

Compiled Monthly by the Edison Electric Institute—Covers 100% of the Industry

DURING THE MONTH OF MAY

	1933	1932	%
Kilowatt-hours Generated* (net)			
By fuel	3,341,139,000	3,369,554,000	− 0.8
By water power	3,139,633,000	2,783,036,000	+12.8
Total kilowatt-hours generated	6,480,772,000	6,152,590,000	+ 5.3
Additions to Supply			
Energy purchased from other sources	175,468,000	196,074,000	−10.5
Net international imports	32,399,000	38,093,000	−14.9
Total	207,867,000	234,167,000	−11.2
Deductions from Supply			
Energy used in electric railway depts.	49,372,000	70,120,000	−29.6
Energy used in electric and other depts.	106,581,000	97,083,000	+ 9.8
Total	155,953,000	167,203,000	− 6.7
Total energy for distribution	**6,532,685,000**	**6,219,554,000**	**+ 5.0**
Energy lost in transmission, distribution, etc.	1,295,380,000	1,121,639,000	+15.5
Kilowatt-hours sold to ultimate consumers	**5,237,306,000**	**5,097,915,000**	**+ 2.7**
Sales to Ultimate Consumers (Kw-hrs)			
Domestic service	907,441,000	912,499,000	− 0.6
Commercial—Small light and power (retail)	968,591,000	1,006,561,000	− 3.8
Commercial—Large light and power (wholesale)	2,772,354,000	2,579,505,000	+ 7.5
Municipal street lighting	167,140,000	178,842,000	− 6.5
Railroads—Street and interurban	314,487,000	334,369,000	− 5.9
Railroads—Electrified steam	54,665,000	43,090,000	+26.9
Municipal and miscellaneous	52,628,000	43,049,000	+22.3
Total sales to ultimate consumers	5,237,306,000	5,097,915,000	+ 2.7
Total revenue from ultimate consumers	$141,162,700	$146,307,700	− 3.5

DURING TWELVE MONTHS ENDING MAY 31st

Kilowatt-hours Generated* (net)			
By fuel	44,093,871,000	53,117,793,000	−17.0
By water power	30,986,026,000	29,335,905,000	+ 5.6
Total kilowatt-hours generated	75,079,897,000	82,453,698,000	− 8.9
Purchased energy (net)	2,602,546,000	2,813,230,000	− 7.5
Energy used in electric railway and other depts.	1,975,716,000	2,261,700,000	−12.6
Total energy for distribution	**75,706,727,000**	**83,005,228,000**	**− 8.8**
Energy lost in transmission, distribution, etc.	13,835,831,000	13,985,890,000	− 1.1
Kilowatt-hours sold to ultimate consumers	**61,870,896,000**	**69,019,338,000**	**−10.4**
Total revenue from ultimate consumers	$1,772,796,400	$1,927,194,100	− 8.0
Important Factors			
Per cent of energy generated by waterpower	41.3%	35.6%	
Average pounds of coal per kilowatt-hour	1.46#	1.50#	
Domestic Service (residential use)			
Average annual consumption per customer (kw-hr)	596	591	+ 0.8
Average revenue per kw-hr (cents)	5.57¢	5.66¢	− 1.6
Average monthly bill per domestic customer	$2.77	$2.79	− 0.7

*By courtesy of the U. S. Geological Survey with deductions for certain plants not considered Electric Light and Power Enterprises.

BASIC INFORMATION AS OF MAY 31st

Generating Capacity (kw)—Steam	24,024,700	24,124,900
—Water power	8,963,900	8,893,000
—Internal combustion	457,200	450,100
Total generating capacity in kilowatts	33,445,800	33,468,000
Number of Customers		
Farms in Eastern Area (Included with Domestic)	(503,771)	(497,593)
Farms in Western Area (Included with Com'l—Large)	(203,979)	(208,502)
Domestic service	19,699,071	20,007,221
Commercial—Small light and power	3,652,878	3,708,981
Commercial—Large light and power	522,022	557,106
All other ultimate consumers	70,628	64,211
Total ultimate consumers	23,944,599	24,337,519

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EDISON ELECTRIC INSTITUTE BULLETIN

Volume 1 JULY, 1933 Number 4

MORE LIGHT—BETTER SIGHT

October and November Are Selected for Lighting Sales Program

Following closely upon the proposal made at the Convention last month by Mr. George E. Whitwell, Chairman of the Sales Committee, Edison Electric Institute, that a vigorous program aimed at increasing lighting sales should be inaugurated in order to combat the downward trend in energy output for lighting, the Sales Committee has approved the general plan and the first steps in launching the program have been taken. Direct charge of the lighting promotional program has been placed in a special committee of which Mr. M. E. Skinner, Assistant Vice-President, Niagara Hudson Power Corporation, is Chairman. The committee includes Mr. H. F. Barnes, General Electric Company, Cleveland; Mr. J. F. O'Brien, Westinghouse Lamp Company, New York, and Mr. C. E. Greenwood, Commercial Director, Edison Electric Institute, where details of the program will be carried through.

All branches of the electrical industry, through their national trade associations, have been invited to participate and assist locally in setting up a plan of procedure to further the cause of good lighting in their respective communities. Other trade organizations interested in the merchandising of lamps or lighting equipment are being mobilized. Lamp and fixture manufacturers who advertise nationally will tie-in their advertising with the activity during October and November, but the major advertising and sales promotion will come from local groups.

It is expected that lamp manufacturers will increase their advertising coverage this Fall in order to give further impetus on a national scale to the efforts of local organization. Fixture manufacturers have on the market new and improved lighting units and portables which will be featured.

PRESIDENT CORTELYOU ENDORSES PROGRAM

Mr. George B. Cortelyou, President of the Institute, has addressed the following letter to member company executives:

"Revenue from lighting service for a number of months has been appreciably affected by the reduced use of lighting. It is believed that this curtailment has reached the point where it is as injurious to the welfare of our customers as it is prejudicial to company revenues.

"The Sales Committee of the Edison Electric Institute, with the approval of the Operating Committee, proposes that during the months of October and November of this year the sales efforts of electric light and power companies be directed toward recovering this lighting load.

"The Sales Committee plans to coordinate its program with the sales efforts of the manufacturers of lamps and lighting equipment. Steps toward that end are already in progress.

"I feel that we should all be strongly impressed by this proposal of the Sales Committee, because the present appears to be an opportune time to focus the attention of the industry on this potential field for immediate increase in revenue."

Chairman Whitwell in a letter to commercial executives of utility companies, and others, has outlined the general schedule of activity and asked for unified support.

Mr. Whitwell brought out in his Convention address that a lighting program to recover lost revenue was timely and could be made highly profitable. It has been emphasized that although the activity is planned on a national basis, it is intended for local development and execution. Every utility company has been urged to conduct some major lighting activity during the eight weeks of the program either in the domestic, commercial or industrial field.

Mr. Skinner's committee has determined on the slogan "More Light—Better Sight," and the advertising themes will be built around this slogan. Let there be more light, for light has a direct bearing on the conservation of eyesight, comfort, health, safety, and convenience of the individual, and on sales and profit to the manufacturer, wholesaler, dealer and utility. With the numerous sales appeals that can be built around better lighting together with renewed inclination on the part of the public to buy, effective work can be achieved by the lighting fraternity this Fall.

During the latter part of July the first issue of *Lighting News* will be printed and distributed. The name is expressive, and this publication will contain just what its name implies. This news sheet will be issued periodically before and during lighting months.

Members of the Sales Committee representing a wide coverage in electric meters have assured Chairman Whitwell of their active cooperation. Letters are daily being received by President Cortelyou from leading utility executives assuring support in the movement.

The stage is set for coordinated action locally by all groups concerned in the sale of light and lighting equipment. Let us make another forward commercial step in our recovery program.—C. E. G.

MAY ELECTRIC REFRIGERATOR SALES BROKE ALL RECORDS

Bureau Campaign Forges Ahead of Quota for First Time This Year—Chairman Davidson Outlines Activities for Balance of the Year

Sales of electric refrigerators throughout the country in May smashed all records for a single month in the history of the electric refrigeration industry. Basing its figures on the actual sales reported by the N.E.M.A. group of manufacturers and all available information gathered from other sources, the Electric Refrigeration Bureau estimates the May total sales at 212,770 units. This figure compares with 127,917 sold in April of this year and 131,946 in May of last year.

The month's total exceeded by approximately 36 per cent that of the highest previous month, April, 1931, when, according to the Bureau's records, 156,248 units were sold. The second highest previous month was June, 1932, when the impending Federal tax of 5 per cent was largely responsible for a buying rush which carried the total to 151,774.

The May figure brought the total for the first five months of the current year to 453,330 which, compared to the five months' quota of 417,128, shows a quota realization percentage for the entire country, as of May 31, of 108.6 in this year's promotion campaign of the Bureau. The quota objective for the year is 800,000 units, and with a number of the leading manufacturers reporting that the June sales maintained the pace set in May, that objective now seems certain to be realized.

TWENTY-NINE STATES EXCEED QUOTAS

Twenty-nine of the 48 States are now ahead of their quotas, the list including Massachusetts, Rhode Island, Delaware, Maryland and D. C., New Jersey, New York, Pennsylvania, Kentucky, Ohio, West Virginia, Kansas, Missouri, Nebraska, Arizona, Nevada, Montana, Alabama, Georgia, North Carolina, South Carolina, Tennessee, Virginia, Colorado, New Mexico, Wyoming, Arkansas, Louisiana, Oklahoma and Texas. At the end of May North Carolina led all the other States with a percentage of 193.4, followed by Alabama with 183.7 and Virginia with 181.9.

A comparison of the figures of May with those of April of this year and May, 1932, shows astonishing gains in many States. Pennsylvania, for instance,

(*Continued on page* 129)

ELECTRIC REFRIGERATION BUREAU

SALES—HOUSEHOLD MODELS ONLY—FIRST FIVE MONTHS 1933

	Years Quota	Five Months Quota—52%	Estimated Total Sales	% Quota Realization
New England Division				
Connecticut	15,316	7,964	7,378	92.6
Maine	6,234	3,242	2,499	77.0
Massachusetts	39,027	20,294	23,512	115.8
New Hampshire	4,009	2,085	1,651	79.1
Rhode Island	6,435	3,346	3,941	117.7
Vermont	2,626	1,365	1,227	89.8
Eastern Division				
Delaware	1,607	836	1,187	141.9
Maryland and D. C.	15,944	8,291	15,082	181.9
New Jersey	39,021	20,291	20,432	100.6
New York	123,949	64,453	72,271	112.1
Pennsylvania	68,754	35,752	44,801	125.3
East Central Division				
Kentucky	8,934	4,646	6,521	140.3
Ohio	51,228	26,639	27,887	104.6
West Virginia	6,149	3,198	5,597	175.0
Middle West Division				
Iowa	15,232	7,921	6,324	79.8
Kansas	11,343	5,898	6,077	103.0
Missouri	22,078	11,481	18,685	162.7
Nebraska	7,837	4,075	4,165	102.2
Pacific Coast Division				
Arizona	2,295	1,193	1,344	112.6
California	62,735	32,622	23,457	71.9
Nevada	569	296	333	112.5
Northwest Division				
Idaho	2,582	1,343	914	68.0
Montana	2,785	1,448	1,626	112.2
Oregon	7,893	4,105	3,047	74.2
Utah	3,850	2,002	1,695	84.6
Washington	14,270	7,420	4,526	60.9
Southeastern Division				
Alabama	5,470	2,844	5,227	183.7
Florida	7,687	3,997	3,359	84.0
Georgia	6,537	3,399	6,023	177.1
North Carolina	8,601	4,472	8,649	193.4
South Carolina	3,427	1,782	2,787	156.3
Tennessee	7,830	4,072	5,300	130.1
Virginia	8,733	4,541	8,262	181.9
Great Lakes Division				
Illinois	61,455	31,957	31,443	98.3
Indiana	22,386	11,641	9,470	81.3
Michigan	35,191	18,299	12,870	70.3
Wisconsin	20,689	10,758	6,936	64.4
North Central Division				
Minnesota	15,809	8,221	6,819	82.9
North Dakota	1,996	1,038	882	84.9
South Dakota	2,558	1,330	1,187	89.2
Rocky Mountain Division				
Colorado	6,745	3,508	4,234	120.6
New Mexico	1,091	567	781	137.7
Wyoming	1,045	543	649	119.5
Southwestern Division				
Arkansas	3,664	1,905	2,637	138.4
Louisiana	6,525	3,393	3,565	105.0
Mississippi	2,742	1,426	1,413	99.0
Oklahoma	8,346	4,340	6,755	155.6
Texas	20,941	10,889	17,903	164.4
Totals	802,170	417,128	453,330	108.6

LIGHTING FIELDS TO EXPLORE WITH PROFIT

By M. E. SKINNER

Assistant Vice-President, Niagara Hudson Power Corporation, Buffalo, N. Y.

An address before the Third Session of the First Annual Convention of the Edison Electric Institute, Chicago, Illinois, June 7, 1933

At the very outset I would like to voice my opinion that the most profitable lighting fields for us to explore are the old ones with which we are all familiar but which we have, none of us, ever explored completely.

Familiar things are frequently overlooked as Douglas Fairbanks recently discovered. He noticed a rather distinguished looking man wandering about the set. Impressed by his appearance he spent about an hour showing him about. The man was very courteous and appreciative. When it was all over Doug said, "I hope you enjoyed the trip. My name is Douglas Fairbanks and it seems to me your face is familiar." "It should be, Mr. Fairbanks," replied the visitor, "I've been your chauffeur for the last two years."

During the boom years the surging increase in our load made us all rather self satisfied and many of us were deluded into believing that the steady increase in residence use of electricity was due entirely to our remarkable sales technique and the extraordinary job which our Sales Managers were doing. We were doing a good job and comparisons between sales increases attained in the electric light and power industry and in almost any other industry show the utility business to very good advantage. The harsh realities of the last two years, however, have deflated any egotism we may have had and few of us can review our 1929 sales accomplishments in the light of 1933 conditions and feel completely satisfied. There are some who have become so discouraged from the succession of disappointments which they have suffered as to lose heart completely and to adopt a defeatist attitude. Such a course would be fatal in time. Each one of us must pull up his belt a notch or two and go to work harder than ever before. If we look for the brighter side of the picture we will find all around us evidences that intelligent sales management, backed by efforts commensurate with the difficulties which we face, are producing worth while results.

Declining Residence Use of Electricity

May I take a moment to analyze what has been happening to the residence load? Long after the depression had begun seriously to diminish the consumption of electricity by industrial and commercial establishments, our residence load continued to increase at a fairly steady pace. Eventually the effects of the depression began to show themselves in the residence field and our gains gradually disappeared to the point where we finally began to lose ground in our per customer residence consumption. Bear in mind that this reduction in consumption took place despite the fact that appliances were still being sold in substantial volume. True, sales of appliances had declined sharply from their figures of a year or so ago, but goodly numbers were still being sold on to our lines.

A Survey to Get Facts

In an effort to get some facts as to what was going on in the homes of our customers and to analyze more clearly the reasons for the declining residence consumption, a survey was made by one of the operating units of the Niagara Hudson System and I imagine the results attained from this survey could be duplicated in almost any other community in the country. A number of accounts which showed a decreased consumption against the same month a year ago, were selected. They were spread throughout the entire community so that they represented a cross section of all classes of homes and incomes. Interviewers were sent out, armed with a complete history of the current consumption, to find out why the customer's use of service had diminished. Some of the questions which they asked these customers and the proportion of affirmative answers were as follows:

Was reduction in use due to a planned curtailment of expenses?	Yes 54.7%
Has wattages of bulbs been reduced?	Yes 20. %
Has number of lamps been reduced?	Yes 15.7%
Were electric rates the cause of lesser use?	Yes 7.6%
Does customer know amount of money saved?	Yes 29.3%
Does customer know of 1½c. block in the rate and how little it costs for service?	Yes 71.7%

Of the customers contacted, 14.3 per cent were then without work and 6 per cent were on part time. No record, of course, was obtained as the amount by which income had been curtailed in other cases.

Now it is interesting to note that almost half of these customers were making no conscious attempt to curtail expenses by reduced use of service. Only a relatively small percentage were consciously reducing the wattage of lamp bulbs or reducing their number. The electric rate seemed to be a minor factor and a surprisingly large percentage were aware of the 1½c. follow on step in their rate schedule. Nevertheless, all of these customers showed marked decreases in consumption. We made an attempt to find out to what extent the use of specific appliances had been discontinued and we found a substantial number which had been temporarily or permanently retired from service. The appliances which had been removed in the order of the frequency with which they were mentioned were, first, bowl type heaters; second, toasters; third, washers; fourth, refrigerators; fifth, radio. This was in part, of course, explained by the greater frequency with which the individual appliance was encountered on account of existing saturation but it seems to show that many customers who have purchased appliances have not been fully sold on the advantages of their use.

However, the partial or complete abandonment of the use of these appliances does not fully account for the reduction in service used and one is forced to the conclusion that a great deal of it is caused by an unconscious reduction in lighting which has probably been effected by the more frequent use of the admonition to Willie to "Turn out that light."

Residence Lighting Will Continue—A Most Important Market

We are, all of us, victims of our own enthusiasm in many things and I wonder if, in recent years, our enthusiasm for the appliance load has not dulled our interest in lighting. Other surveys recently made by the same company to which I have just referred, disclosed that the proportion of the consumption accounted for by lighting was somewhat higher than the national average figures

which have been frequently given out on this subject. This survey was made in territory where rates are extremely low and this fact might distort the picture in comparison with national averages. But if we take the city homes representing the highest income group and make reasonable assumptions as to the appliance saturation which we can effect, we will be surprised at the important part which residence lighting will play with appliance saturation far in excess of that existing today. We must remember too that the lighting load is susceptible to the consumer's attitude, and habit of use. Unless we continue to sell the customer on a generous use of lighting, its value will depreciate in the customer's mind, in terms of the price asked for the service, to the point where he gives expression to his feeling either through a reduced use of the service or by complaining about the rates.

What Can be Done

All of this is well recognized, but the question is—what to do about it? In the first place we need a more subtle and compelling appeal than we have been using heretofore in order to arouse our customers' appreciation of the value to them of this lighting service and we need a sales technique for presenting our story effectively and economically.

A Field Experiment

Last fall conferences with lighting experts at Nela Park led to a field experiment in Utica, New York, to find a solution for these questions. The purpose of the experiment was:

1. To analyze the possibility of making home lighting sales today.
2. To determine whether eyesight (and energy) conservation would be an appealing and successful basis on which to sell the homekeeper better lighting.
3. To prove whether an intensive sales effort on home lighting could be made a profitable activity for the central station.
4. To secure the reaction of cooperating dealers.
5. To discover the reaction of the customer to this new approach.

The city of Utica was selected for the project for several reasons; most of them taking root in the aim to make every condition of the experiment such that the validity of its results would be unassailable. Thirty-five full days were spent making direct contacts and calls in individual homes, calls aimed to sell better lighting; i.e. to interest the homemaker sufficiently in the eye-conserving value and desirability of higher levels of well controlled light—at least in the living room—so that she would install the recommended wattages and make such changes in equipment as were necessary. In these 35 days, 85 separate homes were visited. These 85 homes represented practically all types of medium class and better homes.

The experiment was carried out by Miss Mary Webber, Home Lighting Specialist of the General Electric Company, under the direct supervision of E. W. Commery, in charge of Residence Lighting, and E. D. Stryker, of the Sales Promotion Department of the same organization, working in cooperation with the Utica Gas and Electric Company organization.

The method of operation during this experiment was to make appointments with women and then to present the subject of home lighting from the point of view of eyesight conservation and the new Science of Seeing. During the experiment a number of different methods for securing appointments were tried but the one which proved to be outstandingly successful was to have the appointment arranged by the Company District Representatives. This company has discontinued the direct sales of appliances but continues a corps of outside men for Sales Promotion activities. These men operate in a given territory and are called District Representatives. The eyesight conserving story was the sales approach used in practically every instance, the few exceptions being in homes where there were neither children nor elderly people and where the woman's interest lay especially in home decoration.

Of course, it takes more than conversation really to sell lighting, and demonstration was the most important part of the home call. A small, compact suitcase was carried, containing such demonstration material as would do a comparable job for the home to that of the well known Weston Kit in the commercial field. A series of photographs illustrating a proper solution of the most common home lighting problems proved of particular interest to most women. Small shades of several types served to convince the woman that she must have shades on all bare lamp bulbs. An assortment of all the standard bulbs for home use made it possible to show startling contrasts between the right and wrong lamp bulbs.

However much a woman's most spontaneous interest may lie in interior decoration, it was, without doubt, the dramatic story told by the footcandle meter that changed lamp wattage. A "How to Light Your Home" booklet was left with each customer, although, of course, a form indicating the specific recommendations made for each individual home would be more effective, and certainly an essential feature in a continued program of this kind.

It was not expected that the complete sale would be made on the first call, although the large number of changes already effected in those homes which were later checked was the cause of no little amazement. A second call was required in many instances to demonstrate some specific bit of equipment needed. Many women wanted to see exactly how the recommendation would really look, and to demonstrate this, the call back was made after dark, when, of course, the most striking effect could be created.

The results of this experiment, which was carried on over a period of 35 working days, were extremely interesting. For clarity and conciseness they will be summarized in the order of the purposes stated for the original experiment.

Possibility of Home Lighting Sales Today

One hundred per cent of the 85 homes visited needed additional lighting. A survey of the lighting conditions existing in the 85 homes visited confirms conditions found in the Home Lighting Survey conducted nationally over 10 years ago; namely, that all homes were about "half lighted." A number of the homes investigated in Utica were better than half lighted, but it is significant that every one without exception needed additional lighting, and not for mere luxury or purely decorative effect, but simply in order to bring that home up to those modern standards founded on the minimum requirements of the new Science of Seeing. Even in one home of very moderate size, where there was an outstanding consciousness and appreciation of the value of electricity as evidenced by an average monthly consumption of 475 kwhr. there was still need for additional lighting!

Seventy-seven of the homemakers—or 91 per cent—proved to be "live" prospects, interested enough so that actual recommendations were made on the first call. In the eight homes in which definite recommendations were not made, only in one instance was this due to lack of interest. In the remaining seven circumstances it seemed more tactful to let the matter rest until a future time when economic conditions change.

To what extent additional lighting is needed may be judged only in part from the recommendations actually

made in these 77 homes. A total of 34,775 additional watts was suggested, averaging 451 watts per home. It must be borne in mind that this figure does not represent the total additional watts possible or even needed, but only such additions as seemed expedient to suggest on the first call. Furthermore, sixty-two per cent of these additional watts recommended were in but a single room —the living room.

The Value of Eyesight Conservation as the Sales Appeal

The effectiveness of this approach can stand on its results.

In an economic situation such as exists today when relentless sales effort is being directed at the householder, she has found it necessary to build up a heightened resistance to all approaches, in self-defense. Add to this condition, which presumes a general curtailment of expenditures, the indifference and lack of consciousness that admittedly has long characterized the popular attitude toward home lighting, and there exists a real test case for the appeal and commercial value of the sales argument utilized. In the present instance, the fact that an increase was made in 80 per cent of the homes bespeaks its worth.

The time element made it impossible to check back on every home visited, but 62 per cent of the 85 homes contacted, or 53 of them, were checked. Of these, 47 had already effected changes. Since it is a fact that the people called upon a second time are representative of the 77 real prospects, the percentage of total acceptance would very likely be as high as the percentage of those cases actually investigated, and it accordingly seems fair to use this figure. The additional watts actually on the lines in the 47 homes which made some changes averaged 220, which would show 15,100 watts of increased connected load for the entire undertaking. This figure is based, as stated, upon the assumption that all 77 of the prospects accepted the idea advanced in the same proportion as in those homes where an actual check was made. The 15,100 watts represent 43 per cent of the wattage increase originally recommended on the first call. In addition to the completely ascertained results, 8,745 watts were, at the conclusion of the experiment, in the process of being added. The exact time of these changes is not predictable. However, their nature is so specific that there is every reason to believe that they will be effected at a reasonably early date.

The Revenue Value To The Central Station of an Intensive Home Lighting Sales Effort

The seven weeks' activity in Utica, extended for a full working year, should result in a conservatively estimated increase in revenue of slightly over $4,100 —a figure certainly in excess of one person's expense.

In addition, as has been noted, there were 8,745 watts in the process of being added, but since it was not on the lines at the conclusion of the experiment, it is not included in the $4,100 figure used above. Some of this additional usage will not require further effort, while some will probably need another call.

Dealer Interest and Cooperation

Even during this short experiment, 12 out of the 19 dealers, who were approached concerning the project, made at least one sale due directly to this activity, and in the case of those who made several sales, there was a decided change of attitude in favor of closer cooperation.

Before any direct contacts with the homemaker were even sought, a call was made upon five electrical dealers, two fixture dealers, three furniture dealers, two department store lamp departments, three gift shops, and four decorators in order to acquaint them with the plan, and to seek their interest and their cooperation to the extent of supplying the kind and quality of merchandise needed for carrying out the lighting recommendations made in the homes. In most cases the interest was lukewarm, but as soon as women actually came to make purchases, the attitude changed, and in several instances exceptional cooperative interest was displayed. For example, one furniture dealer, who sold two and one-half gross of small candle shades, three dozen 18 in. and bridge shades, as well as a number of lamps, due to this activity, sought direct help from Miss Webber in reordering.

Considerable interest was developed, too, among a number of the outstanding architects and builders as a result of discussion held with them individually—discussion aimed at convincing them of the need for readjusting their budgets for wiring and lighting equipment.

Customer Reaction

One outstanding and gratifying impression of the whole experiment lies in the sincere and wholehearted appreciation expressed almost unanimously on the part of those women who were directly contacted. Particularly, of course, in those cases where several calls were made in carrying out the recommendations, the women were touchingly grateful and frankly confessed in more cases than one their incredulity that so much service could be given. Fully half of the women asked if this service would be continued and available later on when many would be better able to carry out recommendations. Architects, builders, and consumers were especially interested and appreciative that the recommendations recognized the part which lighting arrangement can play in the decorative scheme of the interior.

From conversations with the women, there seemed no question but that the explanation and demonstration of the eye-conserving value of correct wattage lamps did much to vanquish the common belief that "higher wattage is urged merely for higher bills!" I think I can best emphasize the uniformly splendid reaction from the customers to this approach and to the service rendered to them by reading Miss Webber's detailed report of one of the individual cases.

A Typical Case

"Mr. and Mrs. B. own their own home which is probably worth about $8,000. They have one daughter in high school, and due to Mrs. B's serious illness over a long period of time they find themselves in very straitened circumstances with large doctor and hospital bills still to be completed. Mrs. B. has not yet regained her health and is in a highly nervous state due in part, undoubtedly, to worry about their financial situation. Their house is small, but situated on one of the better streets.

"Mrs. B's name was taken from the directory. One of the introductory letters was sent to her and an appointment made by telephone. Their home was probably as inadequately lighted as any I contacted in Utica. The sunroom in which Mrs. B. sewed almost every evening, where Mr. B. read, and where the daughter studied, had a single drop cord using, with the decorative glass globe, a 40 watt lamp. The living room had a floor lamp and a table lamp, each equipped with a 25 watt lamp, and there was a pair of wall brackets. The kitchen had a 40 watt lamp in the center fixture and a 25 watt lamp over the sink. The girl read in bed from a 40-watt lamp in an enclosing globe in the center of the ceiling with no local portable.

"Mrs. B. was interested enough in the presentation of the lighting story to ask me to come back on a Saturday evening when her husband would be at home, since any added expense in their budget

would have to be considered very carefully. I made the call back as requested and found Mr. B. trying to do a jigsaw puzzle in the living room with a 25 watt flame tint lamp in the floor lamp beside his card table. The shade was one of the worst sort and to aid himself somewhat he had turned on a 25 watt bare lamp in the wall bracket—a grand glare source! It was almost unbelievable to me that anyone would try to see under these conditions where there was not even a footcandle. His amazement and interest were almost pitiful as I brought some light into the room.

"I had with me the equipment needed to demonstrate the lighting results obtainable from my recommendations. Mr. B. was very much interested but was very anxious concerning both the cost of the equipment and the operation. He had accurate accounts of the electric bills for the past four years, and when we went over his bills in terms of the lighting that they actually had, it was apparent that there was some slip which was soon located in the Japanese lamps they were using. The comparison which was given them of the lighting results from their 25 watt Mazda lamp over their sink was almost unbelievable to them. The fact that I could show them this economy seemed to help a good deal in making the actual sale. Personally, I became so much interested in their need for light that I asked them if I might install what they needed on a two weeks' approval, at which time they could either pay me for it or I would take it out. I had, of course, worked out carefully the estimated added cost per month of operation. Mr. B. consented, and I made the installation the next day. Two weeks later Mrs. B. called me and said she had the check for me and was most effusive in her expressions of gratitude. Four hundred fifty-five watts were added."

HOW TO READ OR WORK
WITHOUT DANGEROUS EYE-STRAIN
THE WRONG WAY
THE RIGHT WAY
THE WRONG WAY
THE RIGHT WAY
THE WRONG WAY
THE RIGHT WAY
Your eyes need plenty of light . . be sure to use the correct size and voltage bulbs for every purpose

Obverse side of chart mentioned by Mr. Skinner—Chart is greatly reduced.

Good Will Value Important

I think you will agree that there was a substantial contribution to improved public relations evident in this particular case which is only typical. Today, our public relations are largely a matter of what our customers think of our rates and I can see no better way in which to sell our customers on the value of the service they are receiving than by calls such as I have described.

Quantity Production Methods Needed

Of course, the problem is how to make enough of those contacts to produce tangible results and to do so without the expenditure exceeding the value of the operation. In other words, we must find some quantity production methods.

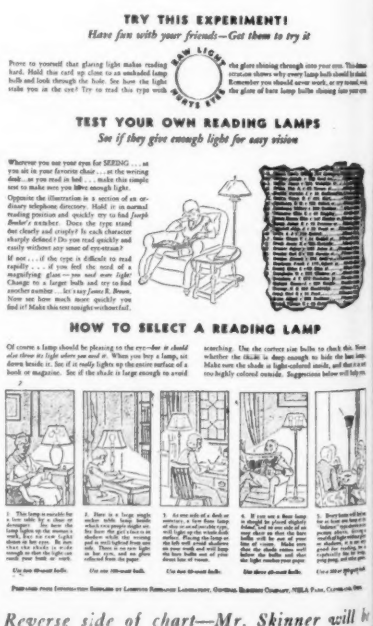
We, all of us, have sales employees calling on our residence customers and it would seem that if we could reduce the elements of home lighting to simple terms so that they could be quickly absorbed by these sales representatives it should be possible through them to get the lighting story over to a large group of our customers at little expense. Working from this premise, a simple approach was developed for the use of outside salesmen or District Representatives. The eyesight conservation appeal was used, and in order to make it more effective, it was aimed specifically at protecting the eyesight of the children in the home.

No attempt was made to go into the elaborate details of a complete home lighting recommendation but simply to develop the fundamentals of how correctly to use light for reading. The appeal was aimed to convince the customer that he should supply a suitable reading lamp at every reading location in the living room of the home and that bulbs used in these lamps should be of proper wattage.

Samples of the chart on which this story was finally condensed will be distributed at the door at the conclusion of this session and I am sure you will all be interested in studying the complete and impressive story which it tells of how to read or work without the dangers of eye strain. We have been using this chart for several months and the District Representatives who give the story to the homemaker and leave the chart with her tell an inspiring story of the way in which it is received. In over 90 per cent of the cases the customer is definitely interested; in better than 40 per cent of the cases he accepts the simple recommendations for additional portable lamps or for increased wattage with every indication that he will carry out the recommendations at the first opportunity. In some 30 per cent of the cases customers' enthusiasm has been such as to indicate that they will immediately make all or most of the changes recommended. In case after case the District Representative is thanked for bringing the information to the customer's attention frequently with the statement, "This is the first time I ever knew that such information was available."

It is planned to use this simplified lighting approach by the District Representative to uncover prospects who would be interested in having a complete lighting recommendation made in their home. With the problem of obtaining appointments eliminated, it should be possible to operate specially trained home service representatives to furnish this story and have the revenue added to the lines amply justify the expenditure. Preparations are being made to get such an activity under way in the fall.

(*Continued on page* 132)


TRY THIS EXPERIMENT!
Have fun with your friends—Get them to try it
TEST YOUR OWN READING LAMPS
See if they give enough light for easy vision
HOW TO SELECT A READING LAMP

Reverse side of chart—Mr. Skinner will be glad to supply a sample of the chart upon request.

DISCUSSION OF MR. SKINNER'S PAPER

By H. M. SAWYER
American Gas and Electric Company, New York, N. Y.

It is my belief that any plans devised for increasing the illumination in one specific class of our business can be employed to increase light applications in other classifications. Mr. Skinner has been kind enough to credit our company with the development of a technique in connection with the commercial field. It is this technique and the results obtained, and also its effect on all classes of lighting business as well as power business, that I propose to discuss. I should like to give due credit for the development of the so-called "demonstration kit" to the members of our own organization—Messrs. Canfield and Megargee—along with the personnel of our subsidiary companies who, through their enthusiasm for and acceptance of the plan, have made it a success. The kit was developed on a very modest scale, with the idea that it could be used not alone in conjunction with commercial lighting sales activities, but that it had its application to residence and industrial lighting as well.

Mr. Skinner has shown you that the "profit" to be secured from this activity is not alone a direct dollars and cents gain but an intangible and none the less substantial return in the good will you may secure from it. Frequently your representatives will not add a single watt to the lines—they may even decrease the customer's load and at the same time give him better illumination. Their most important function is to sell understanding and confidence to the customer and in this way to improve your public relations.

After the plan had been tried out to a modest degree within our properties, we requested manufacturers' assistance.

From initial plans the expansion of the idea to apply in some measure to residence lighting, as described so excellently by Mr. Skinner, was a natural development. For about six weeks, 14 of our home economists have been using the plan outlined by Mr. Skinner and while it is too early to give any definite results, we are confident that the record will show that the faith of Mr. Skinner and the people at Nela Park has been justified.

There is one point which I should like to stress particularly. I cannot impress upon you too strongly my belief in the necessity for educating and training of your representatives in an activity of this sort. Your commercial managers must be shown the full possibilities of the plan and details of its operation. Through them you must rehearse your lighting service men in the use of the kits until they are like well-drilled actors in a play who not only understand the mechanics of the action but can harmonize their parts to every accidental note which may crop out in the interview.

In developing our program we have tried to simplify the technique to the nth degree and at the same time to cover all essential features. The "properties" contained in the kits, to carry the theatrical analogy one step farther, are designed to help the actors and give them cues in this dramatic presentation. For example, we were confronted with the necessity of making fair draftsmen of young ladies who might have no ability along that line, in order that they might be able to make a mechanical drawing of a room to show the location of lights in relation to furniture. Various ideas were proposed and rejected until we hit upon one which seemed to fill the bill. A small template made of transparent celluloid and containing a group of geometrical forms from which a diagramatic sketch of any piece of furniture can be drawn was developed for use with a lighting analysis report. This report contains six printed sheets which, when completed, include the recommendations of the home economist which she leaves with the customer. The report has cross-section paper, with a black sheet back of it. The template is used in connection with this with carbon paper between, and each room can be carefully laid out by the home economist or district salesman or district representative. The report shows also the type of various lighting fixtures, table lamps, stand lamps, etc., and also a lighting analysis sheet, and a story about the science of seeing. This is made in duplicate, and can be kept as a permanent record. We are glad to make all of this material available to the industry and I have a limited number of copies which I can furnish to interested executives.

One of the most interesting side lights to the application of a concerted effort to render a service to our commercial customers has been the results obtained in industrial installations as well. I could spend a great deal more time than has been allotted to me on the program to give you specific examples of these results, but I think that two or three instances will suffice to point out to you the unlimited possibilities of some well organized concerted plan of attack.

Let us look for a moment at one of the first calls which inaugurated our lighting survey work with the demonstration kit. An interview was secured with the executive secretary of an individually owned group of grocery and meat stores in Atlantic City, N. J. On Sept. 28, 1932. The secretary of this store association wrote to our lighting service department furnishing a list of the stores and expressing his conviction that a survey would be of mutual advantage. He suggested that we criticise the lighting in each member store and make a complete analysis of the conditions found in each instance and that the report be filed in the main office of the association.

Surveys were immediately started with these stores and the work has proved to be of inestimable value in fostering a better understanding between these customers and the company and at the same time has served to build up a background of lighting consciousness where it was entirely lacking before.

One of the members, at the outset, was suspicious of our intentions and stated he would allow only five or ten minutes for the interview. It was only a short while until he had forgotten about time and asked so many questions about lighting in general, bills, rates and other matters that Mr. Haney, our lighting service man, spent one hour and fifteen minutes with him and as a result of his report a decided change in the lighting of the store was effected.

Another member of the association capitalized on the use of the maintenance card, which is always left during an interview. A call-back revealed the fact that this merchant had built a very attractive lamp display around the card and had carefully kept a maintenance schedule. He took great pains to point out to others what he had learned from the lighting service man as he had found, by practice, that it was profitable not only from the standpoint of improved lighting in his store but also in the sale of his own merchandise.

In a good-sized community in the Middle West, a chain of drug stores was acquired recently by a very energetic and progressive business man whom we will call Mr. "D". In effecting economies, he found that in a particular location the power company, our sub-

sidiary, was serving him through two meters. It was not unnatural for him to assume that we were deliberately serving him in this way in order to increase our revenue. He lost no time in filing a complaint and did not mince words in expressing his opinion of an organization which would stoop to practices of this sort. The complaint was turned over to the lighting service man who immediately looked up the record of the service and made an appointment to explain the condition to Mr. "D."

The former owners had been approached on several occasions with the suggestion that the two services be consolidated. The amount of saving to be effected had been pointed out repeatedly but because they were in financial difficulties they had short-sightedly ignored it.

This explanation, with the supporting correspondence to prove it, satisfied Mr. "D" on this point, but he still had criticisms and complaints to get out of his system. He had found that the lamps in his Sixth Street Store were burning out very rapidly and had some complaint about the illumination in his windows. It remained for the Weston Illumination Meter to make him an enthusiastic booster for the company. The service man took with him on his call his lighting kit and gave the customer a complete demonstration of the value of light in his business, with the result that Mr. "D" requested a complete survey and check of each of the six stores in his chain. Analyses were submitted for changes in fixtures and interior lighting, increased wattage in windows, the installation of two new signs and the relighting of a sign which had been shut off.

I shall not go into a detailed description of the increase in load secured, as you are all no doubt familiar with the possibilities of this method of approach in obtaining increased wattage. The really important accomplishment is that today Mr. "D" is not only satisfied with the application of light in his chain of stores, but has expressed himself as being deeply impressed with the service rendered by the company and the assistance which was given to him in perfecting the facilities for the display of his merchandise.

A striking example of the value of this activity in improving public relations is to be found in the service rendered to an industrial customer—a large shoe company in Portsmouth, Ohio. The power engineer in that city during one of his periodical calls was asked to make an effort to improve lighting conditions in the plant. In such a factory there are many locations in which perfect lighting conditions are necessary. Leathers must be matched with the greatest exactitude and inspection of the shoes must be carried on in brilliant light with freedom from glare. This power engineer immediately called the lighting service man and a survey of the entire plant was completed. In many instances it was necessary to sit down at the workman's bench and solve his individual lighting problem. While sweeping changes in the installations were not necessary, as the plant was quite modern, enormous improvement in lighting conditions was brought about and one workman noting the better light on his particular job was quoted as having said: "At last the angel has arrived."

Now it is true that we secured some additional lighting load in this plant and incidentally, the power engineer turned up some electric heating applications while he and the lighting service men were studying the lighting conditions, but most important of all, we made a great many friends. These were not confined to the executives of the shoe company, but included a considerable part of the thousands of employees in the plant who appreciated the improved conditions under which they were working.

Another interesting case was developed in the coal industry down in West Virginia. The lighting service man had a neighbor who was connected with a coal company and the coal company employee consulted him with regard to lighting conditions in their tipple. It developed that the coal company was receiving many complaints from customers because of a large amount of bone in the coal and was suffering severe financial loss and losing the good will of their patrons. Our representative went through the tipple and found that extremely poor lighting conditions prevailed above the picking tables and at other inspection points and his recommendations have rectified these conditions. The result is that the coal company has eliminated serious complaint about their product.

With the experience gained in this operation, our representative has inspected the tipples of a number of our largest coal customers and found them invariably poorly lighted. In the Winding Gulf Field alone, six customers were interviewed and all of them were very much impressed with the idea of obtaining better lighting. Without exception they admitted that with present keen competition it was necessary to improve their product, that the labor which they hired for inspecting is no better than the eyes of the individual and that their eyes cannot be expected to function without good lighting in the tipple. Five of these companies requested complete surveys of their present equipment and recommendations for improvement, which were immediately installed.

I cannot improve upon the conclusion drawn by Mr. Skinner, but I should like to amplify that conclusion by the statement that the tools now possessed by the utility can be used to accomplish equally as good results in the commercial and industrial fields as those that he expects in the residence field. He asks one question: "As to the industrial field, is there any reason why these same principles cannot be applied with equal effectiveness?" I am quite sure that you will agree with me that the few examples that I have had time to give you, satisfactorily answer this question.

DISCUSSION BY R. E. FISHER*

Pacific Gas and Electric Company

Residential lighting has for years been recognized by the industry as their most dependable and least competitive source of revenue. In those facts probably lie the secret of why this particular field has never been adequately covered or developed.

In normal years this load showed a steady and very satisfactory increase, not so much due to lighting itself, but from increased usage of appliances. However, with the present tendency toward economies, we are beginning to fully appreciate the fact that our own activity in domestic lighting has been decidedly worthwhile.

Our company serves approximately 500,000 domestic consumers in the Northern half of the State of California. As practically all of the farms in this area are also served from our lines we include rural as well as urban consumers in this discussion.

Domestic lighting is one of the classes of service rendered by this company which has registered a revenue increase each year. Of course, a part of this new

* Read by Mr. John P. Coghlan.

business has come from small appliances, but lighting sales have helped to minimize, if not entirely nullify, the effect of the decrease in the total number of domestic consumers and the loss occasioned by self-practiced economies on the part of thousands of other domestic consumers. Our records indicate that 10 per cent of all kilowatt hour sales and 28 per cent of our total electric revenue is derived from domestic lighting. An analysis of electric usage in the homes of our 500,000 domestic consumers further indicates that approximately 57 per cent of our total domestic revenue comes from lighting, 28 per cent from the use of lamp socket appliances, and 15 per cent from three major electric appliances—ranges, water heaters and air heaters.

Our new business programs both direct and in cooperation with the dealers aimed at the promotion of increased domestic usage cover a wide range of activities, but since lighting represents the larger portion of the total domestic usage, I shall confine my remarks to the revenue possibilities through relighting old homes, which is very attractive.

In the period of six years, through the direct sales efforts of the Pacific Gas & Electric Company and cooperating dealers whose efforts were greatly stimulated by the utility's promotional programs, it is estimated the following number of fixtures were installed:

200,000 kitchen lighting units of 150 watts replacing obsolete fixtures with an average of about 75 watts.
30,000 semi-indirect floor and table lamps, of 200 watts and up, for auxiliary illumination and local lighting.
60,000 semi-indirect living room, dining room and bedroom hanging fixtures of 150 and 200 watts replacing obsolete equipment which averaged less than 100 watts per fixture.

The benefits of this activity have been threefold.

The purchaser was benefited by an improvement in his previously inadequate lighting conditions.
By continually stressing lighting campaigns, there has undoubtedly been developed an educational influence which has helped to develop in the minds of the public a consciousness of improper lighting conditions.
The improved lighting necessitated an increase in load with resultant increased business and revenue for the utility.

We estimate that the 300,000 lighting fixture installations involved in this sustained effort represent approximately $1,000,000 in annual revenue.

The feature of past campaigns, including that of 1932, was the 150 watt direct-type kitchen lighting unit. We are continuing to stress this fixture in 1933, but we estimate that we now have a saturation of 40 per cent or better with this type fixture and we are injecting into our 1933 plans a new element.

We estimate that there are on the lines of the Pacific Gas & Electric Company several million wall-bracket lights using bare lamps of an average of 25 watts each. These fixtures produce neither good illumination nor good decoration and the glare caused by the bare lamps is harmful and entirely out of harmony in the home. Therefore, in addition to the 150 watt and 200 watt semi-indirect hanging fixtures, the direct units for kitchen and breakfast rooms, and the portable lamps, our company is selling a bracket light converter with a 60-watt lamp. This converter consists of an open top diffusing reflector, an adapter which fits around the bracket socket and inside the imitation candle and a parchment shade or shield. This bracket converter, consisting of three pieces—reflector, shade and 60-watt lamp—will be sold for less than $2 each and becomes a small semi-indirect unit which greatly improves this universally used unshaded bracket light. A summary of the general plan for the promotion of domestic lighting by our company in 1933 will most readily convey the objectives we are seeking.

Policy—The company will sell equipment only at prices, terms and under conditions that will permit of the sale of the same devices used by retailing dealers at a legitimate profit. Only units of adequate capacity and efficiency for the uses intended will be sold. The installation of all hanging fixtures will be made by dealers.

Quota—We have set for ourselves for the year 1933, the following rather ambitious quotas:

18,000 direct and semi-indirect kitchen, bathroom, breakfast room, porch and hall units.
3,000 semi-indirect wall bracket converters.
1,500 semi-indirect living room and dining room fixtures.
1,500 semi-indirect table and floor lamps.

24,000 total

Manpower—In order to accomplish this objective we have, at the present time, approximately 70 salesmen engaged on this activity.

Compensation—These men are all on a straight commission basis, commissions being based on a percentage of the cash selling price of the units offered for sale.

We have attached also a conservative revenue value to each of these individual units and have established a revenue quota of $175 per month for these salesmen.

In addition to the commissions offered salesmen who produce the $175 monthly revenue quota, they are also entitled to a monthly bonus which increases throughout the year depending upon the number of months the salesman accomplishes this quota. This bonus starts with $10 for the first month of accomplishment and increases at the rate of $5 per month for each succeeding month in which he attains his quota. Any salesman who makes his quota for 12 consecutive months would, therefore, in the month of December, be entitled to a $65 bonus over and above the commissions earned on the direct sale of fixtures. An annual bonus is also offered for sales in excess of the annual quota.

Advertising—The only advertising used in 1932 in connection with this activity were broadsides which the salesmen themselves mailed several days in advance of their calls.

It is planned this year, however, to supplement this with some newspaper advertising in afternoon papers only.

Mazda Lamps—We are also not overlooking the filling of empty sockets in the homes of our consumers and last year we sold direct to those consumers approximately 366,000 Mazda Lamps which averaged in wattage 59.5 as compared to an average of less than 50 watts on dealer sales.

We are at the present time setting up a basis of compensation for employees which will tend to increase the average wattage and put this activity on a purely load building basis.

One watt average increase on the 366,000 lamps sold by our organization in 1932, and assuming a two-hour daily usage and applying our average domestic lighting rate of 5 cents per kilowatt hour, would have produced 267,000 additional kilowatt hours and $13,302 in annual revenue. This tends to indicate the tremendous load building possibilities in lamp sales. To insure this increase in the average wattage of lamps sold, only those employees who show an average increase will be compensated for their efforts.

We are also at the present time conducting an experiment with our lighting equipment salesmen which we are very hopeful will be successful in aiding these salesmen and also in promotion of business for the dealers. This experiment is being conducted in only one division on our system and is so far working very well.

Our salesmen engaged on this activity are using a 60 watt 10-cent lamp as a door opener to get into the home to talk

to the housewife concerning better lighting. A postcard which reads as follows has been prepared:

"Present this card to our representative when he calls. He will install in one of your lighting fixtures without cost or obligation to you. . . .

"One 60-watt 'American Made' Lamp.

"For the most satisfactory service in home lighting, you should use lamps of known manufacture and proven performance. Patronize a local dealer who sells lamps of American manufacture.

"We are doing this to bring to your attention the way to 'Better Lighting' in the most economical manner.

Compliments of
Pacific Gas & Electric Company"

This card is mailed about 48 hr. in advance of the salesman's call. When he makes his call and delivers the lamp the following information is pasted on the lamp carton itself:

"For Good Light at Low Cost

use

'American Made' Lamps

Buy them from your Local Dealer"

We believe that this advice concerning the purchase of American made lamps will promote business for the legitimate dealers and will also remove practically all of the dealer objection to such a plan. It is too soon as yet to definitely state the effectiveness of this plan, but we are very hopeful for its success.

Pacific Coast Electrical Bureau—One of the most effective and valuable aids to the promotion of both commercial and domestic lighting programs of the utility in California has been the lecture program instituted by the Pacific Coast Electrical Bureau.

This organization is maintaining a very competent man in the field with all the necessary paraphernalia and equipment, who is lecturing before service clubs, Parent-Teachers Associations, schools and women's clubs, on regularly scheduled programs. His lectures are varied to fit the particular conditions or audience to whom he is talking, and they have been a very effective method of developing a background for lighting campaigns by the dealers and utility.

Conclusions—From our own experience we reach the following conclusions:

1. It takes consistent selling effort and educational work year after year to build up this load. Spasmodic sales effort accomplishes nothing.
2. It is a very difficult field to sell as it is hard to develop sales plans which will produce revenue commensurate with sales expense.
3. Because of the high revenue return from domestic lighting and the particularly large field that it presents due to general inadequate levels of illumination found in most homes, we believe that our endeavors in this field have been mutually beneficial to both the consumer and the utility.

DISCUSSION BY OLIVER HOGUE

Commonwealth Edison Company

Electricity sold to residence customers has been increasing from year to year. The rates have been reduced many times. The average customer in Chicago pays less than nine cents per day for electricity. Our study shows that approximately 50 per cent of this amount is for lighting and 50 per cent for labor-saving devices. Rates have been reduced 43 per cent since 1913. Lamp efficiencies have been materially increased. Over a period of years electricity rates have declined more than the cost of living.

How best to contact all residence customers without spending a large amount of money is a serious problem. Our Home Service Division is probably the best medium for contacting the largest number of residence customers. Sixty thousand people were contacted through our free lecture service and lamp shade classes in 1932. Our object was to demonstrate the value of good and proper lighting and the intelligent use of labor-saving devices.

Our Home Service Division furnishes free demonstrations on refrigerators, washers, ironers, and vacuum cleaners, and on request furnish demonstrations on all electrical appliances. We also furnish recipes and information when requested.

Here are some items which have been given special promotional attention:

Aquarium heating—75-watt lighting, 50-watt
Miniature greenhouse for growing dwarf plants—25 watts per foot
Porch lights—60 watts
Electric clocks—2 watts
House numbers—2¾ watts
Hi-Lo lamps—6 and 60 watts
Seasonable and decorative lighting—7½ and 10-watt lamps
Mell-O-Tone chime—5 watts
Small For Rent signs—15 watts
Burglar lighting—100 watts and up, and
Garden lighting and decorative lighting

The Public Service Company of Northern Illinois and the Commonwealth Edison Company campaigned on indirect floor lamps. The former company sold 3000 in six weeks, and the latter sold a like amount in 30 days. It is estimated the income from this lighting will amount to over $6,000 per year.

In sampling homes to find out if customers maintain the full equipment of lamps, we sampled 13,903 customers and received orders for over 98,000 lamps, a total wattage of 5674 kw. The men assigned to this work were specially trained to acquaint the customer with the kind of lamps to be used in the various fixtures throughout the house.

Our District Supervisors are equipped with demonstrating kits, using Weston instruments, making daily and nightly surveys. This has proven very successful. During the year 1932 we contacted 4604 customers and renewed 71,000 lamps. We placed 1680 kw in empty sockets making them income producers.

My personal opinion is that homes in the future will be completely air-conditioned. There will be no exposed lighting. Lighting will be built in the ceiling and the walls, and cove lighting will become more popular. Red Seal wiring will be materially enlarged upon. Full equipment of labor-saving devices will be a part of the home.

With the cooperation of the Electrical Contractors' Association of Chicago we have been conducting an outlet campaign for the past five years. The wiring has been turned over to the contractors. We have also furnished publicity including direct-mail and newspaper advertising. Through our efforts we have installed as high as 50,000 openings in one year. Our advertising has carried the slogan "See your local contractor if you are in the market for additional outlets." A large number have been installed where the sale is made directly through the contractors not included in the Association figures.

Our store business shows a marked improvement. In addition to those opened for the sale of beverages, 61 stores were rented in one week for general business.

I thoroughly believe in demonstration kits, and know they will have a marked bearing on increasing and improving lighting conditions in the home, store, and industrial establishments. This is the best way I know to demonstrate the company's interest in giving the customer the most for his dollar.

TREND OF RATES

A discussion by E. J. FOWLER, Commonwealth Edison Company, of the paper "Trend of Rates" presented by Mr. F. A. Newton at the First Annual Convention of the Edison Electric Institute, Chicago, Ill., June 8th. Mr. Newton's paper appeared in the June issue of the BULLETIN.

I am in hearty agreement with Mr. Newton on many of the important and interesting points brought out in his paper, especially referring to the desirability but the impossibility of extreme simplicity in rates; and especially do I agree with his third rule that for rates to get and hold the business means that they must be promotional. Mr. Newton's suggestion, that any modifications in our rates that are made in these times to sell our surplus and now idle capacity should contain reservation of the right to withdraw such low power rates when conditions return to normal, is an important one. Along with this suggestion I think we might emphasize that perhaps with careful study and thought considerable might be done by our new business and rate men in the way of temporary concessions that would put some of the isolated plant load—that is, at least temporarily—on our systems. I know of some important cases where this has been done.

I am going to present two charts. Chart No. 1 is a load diagram of the maximum day last winter of the Commonwealth Edison Company. You will note that the maximum occurred at 5:30 p. m. You will also note that there is a difference of some 235,000 kilowatts between the all-day load, from eight in the morning until three or four in the afternoon, and the peak load, or a difference of 27 per cent. The load curve of the industry as a whole for the total United States shows a similar situation and indicates that there is about 2,300,000 kilowatts less load during the day than there is at the time of the evening peak. This information for the Nation as a whole has been gathered by the Statistical Department at national headquarters for the past several years. A study of the national curve indicates that over 2,000,000 kilowatts of additional load could be taken on the system without any increase in maximum, providing the kind of load can be found which can operate during the early morning and daylight hours and which can be shut down, or partly so, during the hours of evening peak.

Chart No. 2 is a break-down of the Commonwealth Edison Company's load curve, shown on Chart No. 1, between the important different classes of business which we serve; namely, residential, retail commercial, wholesale and the railway. So far as I know, this is the first time that such an analysis has been presented and I think it is important from a rate standpoint as the data show some of the economic reasons for the difference in some of our rates and perhaps will go even further and show us the way to make other changes in our rates which will help to retain an important group of our existing business and perhaps to obtain greatly increased amounts of this business. The plotting of the total load diagram and the break-down of this into two parts—namely, railway, and light and power—has been simple and is nothing new. The break-down of the light and power between residential, retail commercial, and wholesale is based on a careful survey which we have made by putting recording watt-hour-meters on the low tension side of the transformers supplying seven different residential city blocks selected to represent a cross-section of our residential business, and the installation of similar meters on a representative group of retail commercial customers. This survey was described in the *Electrical World* of Nov. 19, 1932. The wholesale load diagrams have been readily ob-

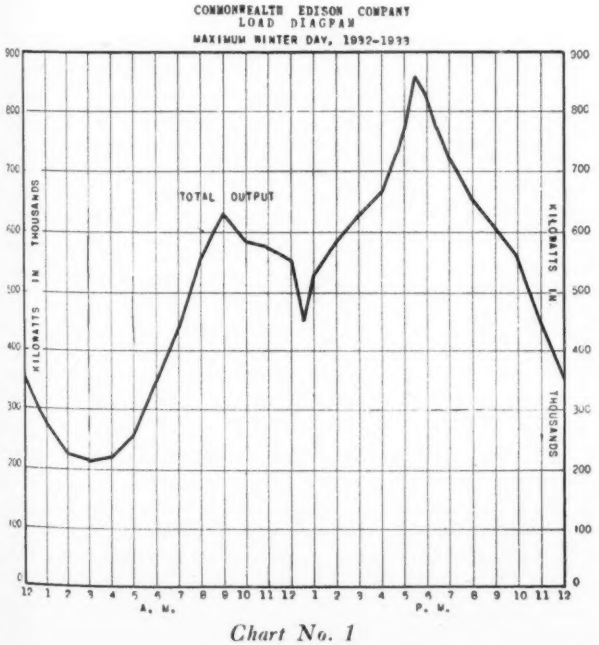


Chart No. 1

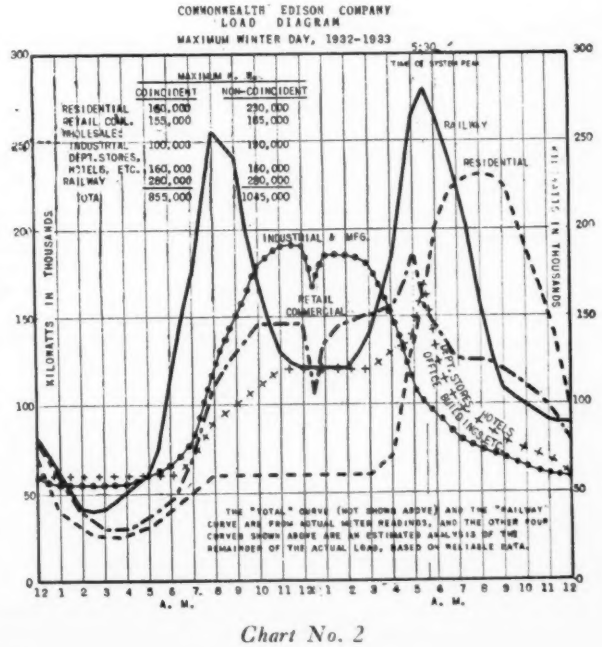


Chart No. 2

tained by adding up the records of the printometer tapes giving the half-hourly readings of the load supplied to our wholesale customers. The division of these loads between the four groups, while based somewhat upon these surveys and data, I consider as reliable. We made one other break-down that is important—that is, we divided the wholesale into two groups: first, industrial and manufacturing wholesale customers; and, second, hotels, office buildings and department stores, or the commercial group of wholesale customers.

Now, as to the important information to be gathered from the charts. In the first place, the railway maximum load comes right on the system peak; second, the commercial group of wholesale customers (hotels, office buildings and department stores) maximum load also comes right on top of the system peak; third, the retail commercial maximum occurs almost on the system peak, being in this case only one-half hour earlier; fourth, only two-thirds of the residential load is on at the time of the system peak —that is, there is a material diversity between the residential and the system load, the residential peak occurring at eight o'clock in the evening and the system peak at five-thirty; fifth, only slightly over one-half of the load of the industrial and manufacturing group of wholesale customers is on at the time of the system peak, indicating the largest diversity of any group of our business—their maximum demand occurs between eleven and twelve in the morning and from one to three in the evening.

Now, as to the value of these data from a rate standpoint, I agree with Mr. Newton that the retail commercial rates should not be higher than the residential rates. The facts here presented, showing that the retail commercial as a group has no diversity whatever and that the residential has a very material diversity, are, perhaps, an explanation of why the residential rates should be only a little higher than the retail commercial. Of course, the average size of retail commercial customer—that is, the average kilowatt-hour use—is several times larger than that of the average residential customer, and his average load factor is also somewhat better than that of the residential.

Now, as to the wholesale: It seems to me that we have two distinct groups of wholesale customers and I want to present the thought that these two groups should be recognized in our rate structure. The industrial and manufacturing group of wholesale customers are usually not located in the business section of the city as are the other group of wholesale customers; in fact they are more often located, especially if they are of any considerable size, in the outer portion of the city on a railway where they can get in their coal cheaper, and where space is not so valuable. So, from a competitive standpoint our rates should differentiate between these two groups if we are to supply all of this business that is available. If the shorter hours of work for manufacturing industries that are being advocated in recently suggested legislation become effective, this diversity between the industrial load and the load at the time of the system peak can probably be further increased. The 1929 United States census of manufacturers shows that there is a little less than 23,000,000 horsepower of factory electric motors operating on purchased power, and also that there is a total of 20,100,000 horsepower of factory machinery supplied from their own prime movers or power—in other words, this census shows that factory machinery is only 53.1 per cent electrified on purchased power, and that there is 20,100,000 horsepower of this business, a large part of which is a possible market for us. Of course I know that in some companies the industrial business creates a system peak, but from a national standpoint they should be able to buy day load capacity from neighboring companies whose peaks are, as the curve shows, evening peaks. And that, too, is being done on quite a large scale in one case that I know of.

I am not going to attempt here to say just what form our rate structure should take to further promote this class of business. It may be that our standard wholesale schedules should have off-peak features which would reduce the primary charges in proportion as the load is off at the time of our system peak, or it may take the form of class rates for certain types of industrial and manufacturing; but I maintain that we can make as much money on very low rates on this class of business as we can on much higher rates for residential and other groups of business. I also wish to express the opinion that the only way to continue the general downward trend of our residential and retail rates is to further improve our load factor by building up this large field of industrial business.

The centralization of practically all of the electricity requirements of a community on one interconnected system constitutes one of the most important factors in the realization of low cost power supply, and this cannot be accomplished without proper consideration in the rate structure of all of the economic factors involved and the characteristics of the loads of the different classes of business. A comprehensive development of large volume wholesale industrial business makes possible the establishment of low rates for residential and retail commercial customers. Further I would say that, without this development of wholesale business, the retail and residential rates throughout the country would necessarily be much higher than at present.

PUBLIC UTILITIES AND THE PEOPLE

Public Utilities and the People. By William A. Prendergast, former Chairman of the Public Service Commission of New York State. D. Appleton - Century Company, New York, $3.00.

This volume may well be described as one of the outstanding books of the decade upon Public Utilities and their regulation, written by a man who has had a unique opportunity of viewing all sides at first hand. In his treatment of a highly controversial subject, Mr. Prendergast sets forth the fundamentals in clear and simple style. Avoiding the frequent practice whereby each pot points to the other's kettle and calls it black, he maintains a non-partisan attitude wherein the arguments of the critics and defenders of the utilities are concerned. Throughout the book, however, he strictly maintains his thesis that "the fact is that regulation of utilities by State commissions is a new and surprisingly effective contribution to government. It is an institution clearly indispensable if we are to cope successfully with the present economic and business organization of the country. It should be perfected and strengthened. It cannot be allowed to fail or 'break down.' "

The book contains a clear explanation of the technicalities of rate making which the layman will thoroughly appreciate. The chapters on the rate of return and on valuation are likewise of great value.

"Public Utilities and the People" is recommended for the study of all those interested in the "utility question" and especially to those sufficiently liberal-minded to hope for its most equitable solution.—W. M. C.

OUTAGES, SERVICE STANDARDS AND INVESTMENT

How a Thorough Understanding of Outages, When Combined With Carefully Considered Service Standards and Investment Analyses, Forms the Basis for the Control of Investment in Electrical Systems

By S. M. DEAN*

The Detroit Edison Company

A paper presented before the Second Session of the First Annual Convention of the Edison Electric Institute, Chicago, Ill., June 6, 1933

I—Introduction

Almost everyone engaged in the electric light and power business knows in a general way that investment charges form an important part of the cost of doing business. They usually associate investment charges with interest and dividend payments. What they fail to appreciate is the fact that some 80c. of every dollar of gross income is spent for items proportional to investment, whereas only 20c. is spent for items proportional to load—which is to say, earning power. Said differently, this means that being ready to serve causes 80 per cent of the total cost of doing business.

This can be appreciated when it is realized that interest, dividends, most of maintenance materials, depreciation, taxes, practically all labor, and miscellaneous charges are caused by physical plant, whereas only fuel burned and a small part of maintenance materials and of labor are proportional to the load.

It therefore behooves us to watch closely the system investment to insure its being kept to a minimum consistent with good service.

Let us look for a moment at the process by which systems grow, that is, how system investment comes about. An electrical system is the aggregate of a large number of extensions, most of which are relatively small. If these extensions have been wisely made in accordance with some comprehensive plan, then the system will have been wisely made. If not, then the system may be too large, too costly, or inadequate. It should therefore be borne in mind that the success of your system, from an investment point of view turns on the wisdom of the day to day decisions. Some are made by yourself but many are made by your subordinates, often, if not usually, without adequate guidance.

II—Purpose of Paper

It is the purpose of this paper to show how adequate operating records and carefully considered standards of service, coupled with investment analyses, may provide the indices by which these day to day decisions, and thereby the investment, may be more intelligently controlled.

III—Reasons for System Extensions

System extensions are, or should be, made only (1) when the load has grown to the point where reliability reserves are being encroached upon, or (2) when the allowable limits of voltage regulation have been exceeded, or (3) when the allowable limits of lamp flicker have been exceeded.

Generally speaking, the reliability reserve limitation applies from the generating plant to and including the distribution substation. The voltage regulation limitation applies to transmission, subtransmission and distribution

TABLE I—OUTAGE EXPECTANCY FOR LINES AND EQUIPMENT

1. Generators.
   Single generator accidental outages per generator per year — .02 } Approx.
   Single generator scheduled maintenance outages per generator per year (of 26 days duration each) — .40 }
2. 120-kv. Double Circuit Overhead Transmission.
   Single circuit outage per 100 miles of tower line per year—7.2
   Double circuit outage per 100 miles of tower line per year—1.6
   92.6%—Transient trouble—Average Duration 9 minutes
   7.4%—Persistent trouble—Average Duration 673 minutes
   (These apply to both single and double circuit outages.)
3. Bulk Power Stations. (Defined on page 115.)
   (a) Outdoor—Number per year per station—.05
   Average duration—40 minutes
   (b) Indoor—Number per year per station—.04
   Average duration—10 minutes
4. Overhead 24-kv. Subtransmission.
   Outages per 100 miles per year—31
   18%—Long duration
   For loop lines—30 minutes each
   For radial lines—5 hours each
   82%—One minute each
   (Where possible use record of the particular line or a similar line.)
5. Underground 24-kv. Subtransmission.
   Outages per 100 miles per year—6.2
   All 24 hours or more duration
6. Distribution Substations.
   (a) Outdoor—Number per year per station—.17
   Average duration—2 hours
   (b) Indoor—Number per year per station—.03
   Average duration—20 minutes
7. Overhead Distribution Lines—City.
   Outages per 100 miles per year—8.1
   93.8%—Automatically reclosed (1 minute)
   6.2%—Not automatically reclosed (average duration 51 minutes—minimum—30 minutes; maximum—2½ hours)
   (Where possible use the operating record of the particular line or a similar line.)
8. Overhead Distribution Lines—Suburban.
   Outages per 100 miles per year—4.5
   71.0%—Automatically reclosed (1 minute)
   *29.0%—Not automatically reclosed (average duration 130 minutes)
   (Where possible use operating record of the particular circuit or a similar circuit.)
9. Underground Distribution Lines.
   Outages per 100 miles per year—3.0
   All eight hours or over

*This includes partial outages.

*The author acknowledges with thanks the assistance of Messrs. E. R. Moore, N. A. Pope, and H. P. Seelye in the preparation of this paper.

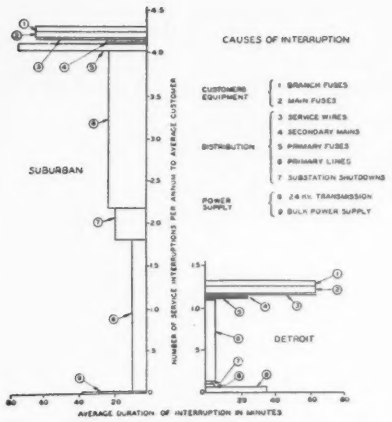


Fig. II. Frequency Duration and Causes of Interruption to average Customer Served From Overhead Distribution Lines

lines. The lamp flicker limitation usually applies to distribution lines but may also apply to substations and subtransmission lines if the loads are large and the fluctuations are frequent, as is often the case with large electric furnaces, welders, rolling mills, etc.

IV—The Outage Record as a Background for Decisions

Essential to passing judgment on system extensions is a thorough-going knowledge of system outages, from the standpoint of line and equipment outage and of customer outage. It will prove costly enough to design system extensions to protect against all the situations which operating experience shows do in fact, arise, without taking into account the many others which one's imagination may conjure up.

Table I gives the outage expectancy for lines and equipment as determined for The Detroit Edison system.

It is difficult to keep one's equilibrium when applying the values of line and equipment outage expectancy as outlined in Table I. This is particularly true if one has recently endured a major bus fault or something equally embarrassing. The tendency is often to rush into large expenditures to avoid a possible recurrence of that particular trouble, whereas an analysis of just whose service was in fact impaired, and how much, and how often, will go far to eliminate excess enthusiasm—and expenditure.

Figure II shows such an analysis covering the number and average duration of outages per year by causes for the average residential, commercial lighting, or power customer served from the overhead distribution lines of The Detroit Edison Company. Separate values are given for its Detroit City territory and its Suburban and Rural territory. You will note at once the almost negligible effect of bulk power source failures. Such outages look large when they occur but it is worth very little, at least to the Detroit system, to reduce them below their present rate of occurrence. It is perhaps fair to ask if we have not already reduced them too far, considering what it cost to do so. You will also note what a large proportion of the troubles are due to the customer's own equipment. This is shown by main and branch fuse blowing. These troubles are largely beyond our control.

Secondary and service wire troubles are negligible.

Therefore, the suburban troubles which will bear investigation are those occurring on the 24-kv. subtransmission lines, the distribution substations, and the distribution lines. In Detroit where 24-kv. subtransmission is in cable, and distribution substations have little lightning exposure, the preventable troubles are confined to the distribution lines.

Let us turn our attention to the suburban troubles. About half of the four and one-third outages per year are caused by 24-kv. overhead transmission and substation outages. Therefore, these outages should be further analyzed as to time of occurrence and duration. Figure III shows them plotted by months against hour of the day. Hours of darkness are shaded. Solid black dots are outages longer than one minute. You will note the almost complete absence of long outages during the lighting hours, that is, up to midnight. *It is therefore evident that, as far as lighting service is concerned, we cannot afford further expenditures to reduce 24-kv. transmission and substation outages.* Also, since suburban service is largely lighting and incidental power, it is apparent that further expenditure to reduce daytime outages which largely affect power customers, should be confined to cases where a careful analysis shows it to be justified. Examples of such analyses appear in Part VII.

The other large factor in suburban outage is the distribution lines themselves which cause two out of the four and one-third outages per customer per year with an average duration of twenty-two minutes. The record of a particular distribution circuit may vary considerably from the average as shown. It is therefore advisable, where possible, to use the actual operating record of the particular line or a similar line. Analysis of outages from this cause likewise shows a tendency to concentrate outside lighting hours, much the same as did those due to 24-kv. lines.

Table IV shows in detail the number and duration of suburban distribution line outages by causes.

On the city distribution circuits, the controllable outages of consequence are only those of the distribution lines themselves. These account for .9 interruptions out of a total of 1.3 per average customer. Table IV shows in detail the number and duration of these outages by causes.

V—The Divisions of an Electrical System

At this point it is necessary to digress long enough to establish the essential divisions of an electrical system.

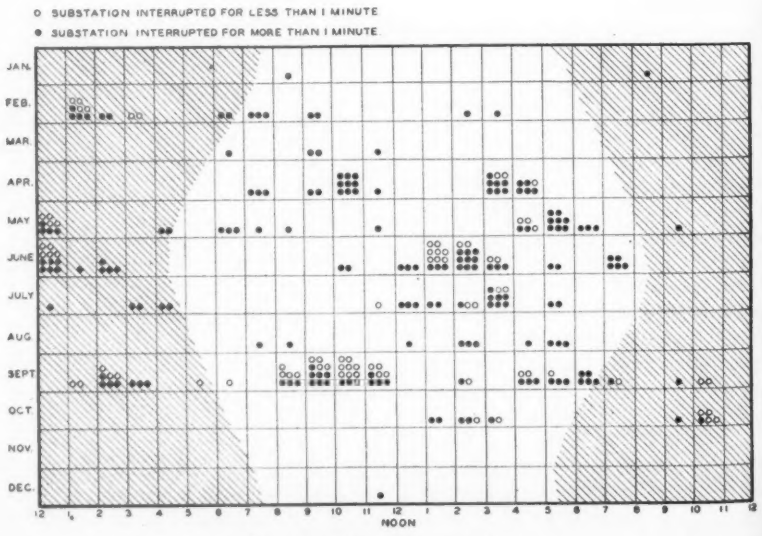


Fig. III. Substation outages

Such a system naturally falls into two classifications.

The first is the Bulk Power System, the purpose of which is to provide a reliable supply of power to the various load areas of the system. A Bulk Power System may range from the one extreme of a single small generating plant, which feeds at generator voltage directly into a single load area, consisting only of a distribution system—to the other extreme of a large number of generating plants tied into a great network of high voltage transmission lines which serve many bulk power stations each serving a load area. A Bulk Power System therefore comprises all power plants, high voltage transmission lines and their step-down stations, which are used to supply power to the subtransmission voltage lines which feed the distribution substations. To these should be added such subtransmission voltage lines as are used in emergencies to transfer bulk power between load areas.

The second classification comprises one or more load areas which make up the balance of the system. A Load Area consists of all the subtransmission lines fed from one bulk power station (power house or transmission step-down station); the distribution substations fed by these subtransmission lines; all distribution voltage lines together with distribution transformers, secondary mains and service connections; and the meters on the customers' premises. There may be any number of load areas depending on the size and arrangement of the system.

The advantages of such a classification are: (1) That every system of whatever kind has its bulk power sources and its load areas and data compiled on such a basis for several systems should be comparable; (2) That these are the divisions into which system investment naturally falls. To illustrate, the total bulk power investment charged against a bulk power station, which feeds a load area from a transmission system, is the money which has been spent in lieu of building a local power plant to serve that load area. To illustrate further, the subtransmission lines, the distribution substations, and the distribution system are the same whether served by a local power plant or a transmission step-down station.

VI—The Analysis of Existing System to Insure Its Maximum Use Before Making Extensions

Having developed a background of operating outage data and a classification into Bulk Power System and Load Areas, the next step is to analyze the existing system in the light of outage expectancy data similar to that in Table I, peak load duration, etc., for the purpose of determining the necessary reliability reserves and from them the firm rating of the different component parts. Having determined the firm ratings, the investment allocated against them can be expressed in terms of firm capacity and of peak load which are the true indices.

TABLE IV—DISTRIBUTION LINE BREAKER OPENINGS PER YEAR
AVERAGE FOR THE YEARS—1928-1932

	Interruptions							
	City (Banked Transformers)				*Suburban (Unbanked Transformers)			
Causes	Number	Average Duration in Min.	% of Number	% of Duration	Number	Average Duration in Min.	% of Number	% of Duration
Wind, Sleet and Trees	46	4.5	23.6	25.0	69	14.1	35.1	41.0
Lightning	41	2.3	21.0	11.4	43	11.2	21.8	20.5
Public Interference	32	3.1	16.4	11.9	26	11.0	13.2	12.1
Equipment Failures	12	17.7	6.2	25.4	17	19.9	8.6	14.3
Employes' Errors	18	3.6	9.2	7.7	15	2.6	7.6	1.7
Customer's Fault	..	..	..	..	1	14.5	.5	.6
Miscellaneous	7	8.4	3.6	7.0	11	15.0	5.6	7.0
Unknown	39	2.5	20.0	11.6	15	4.4	7.6	2.8
Total ...	195	4.3	100.0	100.0	197	12.0	100.0	100.0

	City	Suburban
Average number of lines	236	165
Average number of interruptions per line	.8	1.2
Average duration of interruptions per line in minutes	3.5	14.3

*To these suburban outages should be added 207 cases of partial circuit outage caused by wires burning down without circuit breaker openings. These average three hours and forty minutes each and involve, on the average, 15% of the total circuit.

There must also be added to suburban circuits some 4000 cases of fuse blowing per year, which in the aggregate interrupt 5% to 10% of all the suburban customers for an average period of seventy-five minutes.

Bulk Power System

Generating Plant—In the light of actual outage data, review the generating plant reliability assumptions taking account of interconnections and tie lines between plants as well as generators. For instance, it is Detroit Edison practice to assume that some one of its twenty-five major turbine units will always be down for maintenance and that a second one may go out of commission at any time. Because a running unit may go out of service in the same plant as that having the unit down for maintenance, *the firm rating of each plant becomes its generating capacity less the two largest units plus the capacity of its ties to its neighboring power sources.** If now the ties to the neighboring power sources are properly proportioned, *then the sum of the firm ratings of the generating plants will equal the total of all effective generating capacity and outside interconnections on the system less the system's two largest generating units.* From this must, of course, be subtracted an amount equal to the system growth occurring during the period necessary to provide additional generating capacity. A further subtraction may have to be made in large wide-spread systems if the generating capacity is not carefully proportioned to the load within reaching distance.

The net result is the firm load carrying capacity of your generating system, and the difference between it and the sum of the name plate rating is the reserve which you have for reliability, seasonal variations in capacity such as occur in water power plants, and inefficient design due either to natural limitations or to inadequate planning.

It is often said that ten, fifteen, or twenty per cent is sufficient generating reserve for an electrical system. *Reserve is not a matter of percentage. It is dependent on the reliability requirements assumed, the size of generating unit selected and the judgment exercised in locating these units in the system. Dollars per kilowatt of net increase to firm generating capacity is the criterion.* These facts should not be lost to view in the desire for large generating units.

Transmission Lines—The place of operating records in the determination of

*Note:—"The capacity of its ties . . ." should include such loads as may be switched to other load areas in an emergency. Such a procedure amounts to contracting the boundaries of a load area to meet reduced generating capacity.

transmission line reserves is well recognized and little need be said of it.

Bulk Power Stations—The next step is to determine, by eliminating reliability requirements, the firm rating of each bulk power station, which is to say, of each load area power source. These power sources, as previously pointed out, may be either step-down stations or generating plants, feeding into the network of subtransmission lines. If it be a transmission station, its firm rating will be its name plate rating, plus the rating of its bulk power ties to neighboring load areas, minus the amount of its reliability reserve. If it be a generating plant, its firm rating will be the name plate rating of its generators and tie lines less the amount of its reliability reserve.

By comparing the firm rating of each bulk power station with the peak load to be served by that station, the degree of overbuild may be determined and the margin for growth estimated. For any one bulk power station the degree of overbuild and margin for growth are each equal to firm rating less peak load. However, practically speaking, the simultaneous margin for growth in all the bulk power stations can never equal the sum of their overbuilt firm capacities. This can be appreciated when it is realized that margin for growth varies from nothing in a station where the peak load just equals the firm rating to the rating of a unit in a station where a new unit has just been added.

Investment Chargeable Against Each Load Area—The total investment chargeable against each load area should next be determined.

The principle we have employed in this investment allocation is as follows:

1. The investment in generating plant is charged against each load area served by it in proportion to the peak load of the bulk power station serving that load area without regard to the time at which that peak occurs.
2. The investment in those transmission and switching facilities provided specifically for the given bulk power station are charged to that load area. The investment in transmission and switching facilities common to several bulk power stations will be pooled and charged to their load areas in proportion to the peak loads of the bulk power stations serving those load areas without regard to the time at which the peaks occur.
3. The investment in each bulk power station will, of course, be charged to the load area which it serves.

The total of the above three investment items for each bulk power station should now be expressed in dollars per kilowatt of firm capacity and also in *dollars per kilowatt of peak load served*. Peak load is *a measure of earning power and dollars per kilowatt of peak load is the measure of investment efficiency*. Sample Charts V and VI show such a tabulation, both for a bulk power step-down station fed from a transmission system and for a bulk power station consisting of a generating plant.

SAMPLE CHART V—BULK POWER INVESTMENT ALLOCATED TO LOAD AREA SERVED BY STEPDOWN STATION NO. 1

39.5% of Generating Station "A"	$11,538,023.05
½ of 120,000 Volt Switching Station "A"	470,196.74
120,000 Volt Transmission Lines A-1	603,396.80
120,000 Volt Switching in Stepdown Station No. 1	463,632.75
24,000 Volt Switching in Stepdown Station No. 1 including Transformers	1,006,065.70
Tie Stations, 24,000 Volt	123,110.68
Tie Cables, 24,000 Volt, including Ducts	419,760.86
Total	$14,624,186.58
Firm Station Capacity in Kilowatts at .9 P.F.	132,000 kw.
Peak Load	99,000 kw.
Overbuild and Margin for Growth	33,000 kw.
Investment per Kilowatt of Firm Capacity	$110.79
Investment per Kilowatt of Peak Load	$147.72

SAMPLE CHART VI—BULK POWER INVESTMENT ALLOCATED TO LOAD AREA SERVED BY GENERATING STATION NO. 2

Power House No. 2	$14,075,327.92
24,000 Volt Switch House No. 2	2,472,000.00
Tie Stations, 24,000 Volt	258,207.12
Tie Cables, 24,000 Volt, including Ducts	1,191,029.78
Total	$17,996,564.82
Firm Station Capacity	150,000 kw.
Peak Load	117,800 kw.
Overbuild and Margin for Growth	32,200 kw.
Investment per Kilowatt of Firm Capacity	$119.98
Investment per Kilowatt of Peak Load	152.77

Central Generation and Transmission versus the Local Plant—A careful consideration of the above method will show it to be valuable in determining the investment which any transmission system would have to charge against a given community when studying the desirability of generation by a local plant. Such situations turn largely on reliability requirements. The steps are as follows:

1. Determine from operating outage records what transmission and station facilities are necessary to give sufficiently reliable bulk power service to the community in question.
2. Determine the total bulk power investment chargeable against this community and the carrying charges on it. Add to these the operating charges.
3. Compare the sum of the above charges with the charges for a local generating plant where practicable, tied into the transmission system by a single circuit transmission line for mutual reserve. If this course is least expensive, that fact can be determined in advance and local plants be built. Presumably the central station company is best able to build and operate them economically.

The Load Areas

Each of the load areas comprising the system should be analyzed as follows:

Subtransmission System and Distribution Substations—From the outage expectancy record determine the subtransmission lines and switching substations necessary for reliability reserves. Generally speaking, line and cable outage assumptions are more conservative than the outage facts will justify.

From that and the distribution substation itself, determine the firm rating of each distribution substation.

The difference between these firm ratings and the peak loads served constitutes the amount of overbuild.

Margin for growth may be derived from overbuild in the same manner set forth for bulk power stations.

An analysis of overbuild and margin for growth offers an opportunity to show the effect on investment of the sizes of transformer units and transmission cables used.

Investment Chargeable Against Each Distribution Substation—The total of the bulk power, subtransmission and distribution substation investment chargeable against each distribution substation should next be determined. The principle we have employed in arriving at these investment allocations is as follows:

1. The bulk power station investment is divided among the substations which it serves in proportion to the substation peak load without regard to time at which that peak occurs.
2. The investment in those subtransmission lines and switching facilities provided specifically for a given distribution sub-

station are charged against that substation. The investment in those subtransmission lines and switching facilities common to several distribution substations are pooled and charged against those substations in proportion to their peak loads without regard to the time at which those peaks occur.

3. The investment in each distribution substation is, of course, charged to that substation.

The total of the above three investment factors should first be expressed in dollars per kilowatt of firm distribution substation capacity and then in *dollars per kilowatt of peak load served. This latter figure is the real measure of investment efficiency.* Sample Charts VII and VIII illustrate this process.

To illustrate the effect of reliability assumptions on cost per kilowatt of firm rating, in Chart VII the assumption of two subtransmission cables simultaneously out of service has been changed to only one out. The cost per kilowatt of firm rating is thereby dropped from $132.50 per kilowatt to $106.30 per kilowatt. That difference is a real inducement to be very sure that it is in fact necessary to assume two cables out simultaneously.

SAMPLE CHART VII—BULK POWER AND LOAD AREA INVESTMENT CHARGEABLE AGAINST SUBSTATION NO. 1
(Industrial)

Bulk Power	$3,044,756.34
Subtransmission, 24,000 Volt	267,249.16
Substation	997,171.51
Total	$4,309,177.01
Firm Power Rating, Kilowatts at .9 P.F. (Basis two cables out)	32,500 kw.
Firm Power Rating, Kilowatts at .9 P.F. (Basis one cable out)	40,500 kw.
Peak Load	20,700 kw.
Investment per Kilowatt of Firm Capacity (Basis two cables out)	$132.50
Investment per Kilowatt of Firm Capacity (Basis one cable out)	$106.30
Investment per Kilowatt of Peak Load	$206.19

SAMPLE CHART VIII—BULK POWER AND LOAD AREA INVESTMENT CHARGEABLE AGAINST SUBSTATION NO. 2
(Residential)

Bulk Power	$879,735.95
Subtransmission, 24,000 Volt	373,600.20
Substation	314,138.37
Total	$1,567,474.52
Firm Power Rating, Kilowatts at .9 P.F. (Basis of one subtransmission cable out)	8,100 kw.
Peak Load	6,840 kw.
Investment per kilowatt of Firm Capacity	$193.39
Investment per kilowatt of Peak Load	$229.16

The Distribution System

In analyzing the distribution system the method of attack must be different from that employed in the Bulk Power System and the Load Areas. This is true because dependence must largely be placed on a single feed, it being impracticable from the investment standpoint, to secure added reliability by providing duplicate or throwover service. It therefore, becomes a question of how these single feeds may be made sufficiently reliable at a minimum cost.

The growing needs of combined residential and commercial city areas having large numbers of electric ranges, refrigerators, oil burners, water heaters, etc., and therefore largely dependent upon continuous electric service, will doubtless call for somewhat better reliability than can be offered by a strictly radial system of distribution. In those parts of the distribution system where congestion requires that primary lines be underground, the solution is the low voltage network. Where overhead distribution can be maintained, at very little increase in cost, it can be made to give a considerably improved grade of service over that provided by a strictly radial system.

The essential features of such an improved distribution system are—

1. Ungrounded neutral.
2. Ringed primary lines.
3. "Banked" transformers.

The ungrounded neutral permits the circuit to operate with one wire grounded until the ground can be located and repaired, thereby eliminating many long outages. The ringed primaries prevent a broken wire from shutting down other than a very small part of a circuit since there is two-way feed provided for a large part of the circuit. The "Banked" transformers permit the loss of any transformer without a service interruption, the transformers being connected in parallel and fused to at least 300 per cent of rating on both the primary and secondary sides. The banking of transformers and the continuous secondary has another advantage in that it gives better voltage regulation and lamp flicker conditions.

I would, however, say a word of warning concerning the practice of "banking" transformers. "Banking" should be employed only on circuits having "ringed" primaries, since a broken primary wire near the source end of a "bank" will almost certainly shut the entire bank down. Also, the "banks" must be carefully designed as to size and location of transformers and the transformers accurately fused. They must be periodically checked for load and for blown fuses. If a company is not prepared to properly design and care for these "banks," they should not be undertaken. However, the reward for this care is the virtual elimination of customer outage due to blown fuses and burned out transformers.

The ungrounded neutral also makes essential the installation of a proper ground detector signal system to permit the prompt location of grounds.

Effect of ungrounded neutrals, ringed primaries and banked transformers on The Detroit Edison Company city system has produced the following operating record for two hundred and twenty 4800 volt city distribution circuits for 1931.

Total cases of broken wires		293
Long interruptions (30 minutes or more to total circuit or major part of circuit)	10	
Long interruptions to minor part of circuit (5 transformers or less)	46	
*Short interruptions (1 minute or less)	44	
*No interruptions	193	
		293

The cost of such an ungrounded, "ringed" primary, "banked" transformer system is little more than that of the ordinary radial system.

It is often contended that the greater expense of overhead low voltage networks fed by multiple overhead primary feeders can be justified in combined residential and commercial sections of cities, that is to say, in districts where the primary feeders are not required to be underground. The most effective answer to that contention is the preceding operating record.

In suburban area and sometimes where streets and alleys are "jumbled" in dis-

*Of the 237 cases covered by these two items, 129 are the result of ringed primaries, 104 the result of banked transformers, and 13 were on dead ends serving no transformers. On a radial primary system not employing banked transformers, 224 of these cases would have resulted in an interruption varying from a single transformer to the major part of the circuit.

There were also over 200 cases of blown fuses, almost none of which caused an outage.

orderly array, ringed primaries and therefore banked transformers are not practicable. In such cases much improved service can be given by ungrounding the neutral and by providing the best of lightning protection. By the best of lightning protection is meant proper arresters and a common arrester and secondary neutral ground. While it is too soon to say definitely, there is some experience to indicate a very marked improvement in protection where the common arrester and secondary ground has been adopted.

Below is the operating record of 165 suburban distribution circuits of the Detroit Edison Company for 1931 on the same basis as for the city circuits. These circuits do not employ ringed primaries or banked transformers.

Total cases of broken wires (78 of these cases breaker openings)	295
Long interruptions (30 minutes or more to total circuit or major part of circuit)	117
Long interruptions to minor part of circuit (5 transformers or less)	81
Short interruptions (1 minute or less)	78
No interruption	19
	295

To this record must be added 3928 cases of fuse blowing which interrupted about 10 per cent of all the distribution transformers on the circuit and we estimate between five per cent and 10 per cent of the customers.

Compare this record with that of the ringed primary banked transformer city circuits just preceding, and note that for the same total number of broken wires on the suburban lines there are nearly twelve times as many long outages to the major portion of a circuit, and only one-tenth as many cases of wires down with no interruption as on the city lines having ringed primaries and banked transformers.

By referring back to Figure II, you can get a visual comparison of the two classes of lines.

SAMPLE CHART IX—DISTRIBUTION INVESTMENT CHARGEABLE AGAINST SUBSTATION NO. 1 (Industrial)

Distribution Lines	$748,647.20
Distribution Transformers	151,267.74
Services	82,527.36
Meters	163,915.56
Primary Customers' Installations	13,506.39
Total	$1,159,864.25
Sum of Circuit Demands, Kilowatts at .9 P.F.	29,100 kw.
Investment per Kilowatt of Circuit Demand	$39.85

	Number	*% Kw. Hrs.*
Primary Power Customers	30	77.7
Secondary Power Customers	390	9.5
Commercial Lighting	1,680	7.9
Residential	8,000	4.9
Total	10,100	100.0

SAMPLE CHART X—DISTRIBUTION INVESTMENT CHARGEABLE AGAINST SUBSTATION NO. 2 (Residential)

Distribution Lines	$311,595.49
Distribution Transformers	114,792.51
Services	73,164.83
Meters	145,319.74
Primary Customers' Installations	
Total	$644,872.57
Sum of Circuit Demands, Kilowatts at .9 P.F.	6,940 kw.
Investment per Kilowatt of Circuit Demand	$92.92

	Number	*% Kw. Hrs.*
Primary Power Customers	0	0
Secondary Power Customers	280	13.1
Commercial Lighting Customers	1,100	42.7
Residential	9,620	44.2
Total	11,000	100.0

It is to be regretted that we cannot also compare the operating record of these suburban lines with that of the 4000-volt grounded neutral lines so commonly used but we do not have any of the latter.

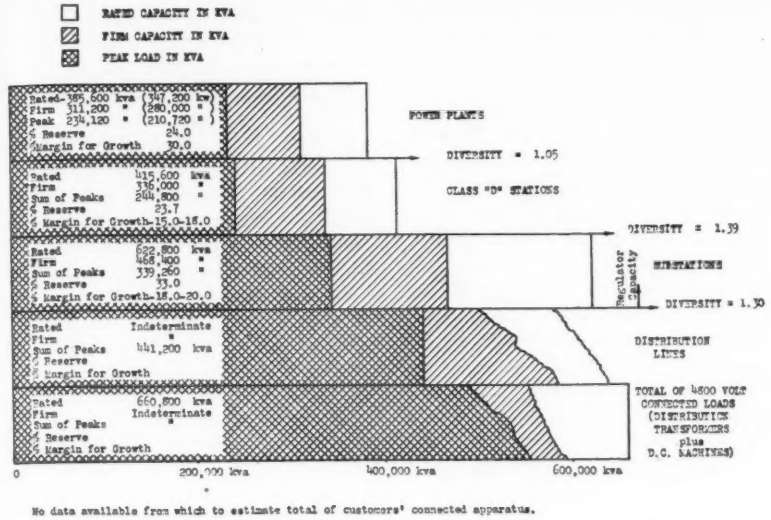
Distribution Investment Charges—It is very difficult to set up investment indices for distribution systems which will illustrate the effect of improved design and construction methods, because the investment is so largely swayed by conditions other than the number of customers and the load carried. The layout of streets and alleys; tree conditions, joint use of poles with telephone companies, fire departments, municipal street lighting; etc., not to mention restrictions imposed by city ordinances, largely rule the cost of the line structures. Farm lines are about the only exception, it being fairly easy to adapt construction to the simple requirements and to keep the accurate cost records necessary to observe the effect of changes in standards and construction.

It is possible, however, to set rough indices which are illustrated by Sample Charts IX and X and which show the variation in investment for varying load densities. The total distribution line investment chargeable against each dis-

SAMPLE CHART XI—TYPICAL ALLOCATION OF TOTAL INVESTMENT AGAINST LOAD AREAS AND DISTRIBUTION SUBSTATIONS
(*Multiply $ by 1000*)

	Subtransmission System															*Distribution Lines*	
	Bulk Power			*Overhead*			*Underground*			*Switching Substations*			*Distribution Substations*				
	Total	*Firm*	*Reserve*	*Total*	*Firm*	*Reserve*	*Total*	*Firm*	*Reserve*	*Total*	*Firm*	*Reserve*	*Total*	*Firm*	*Reserve*	*Overhead*	*Underground*
Typical Load Area	$10,252	$9,005	$1,247	$132	$348	$84	$1,795	$1,175	$620	$500	$250	$250	$3,218	$2,461	$757	$2,605	$1,626
Large Industrial Substation Area	3,994	2,706	388	....	....	...	472	336	136	....	....	....	1,486	1,198	288	271	945
City Lighting Substation Area	734	643	91	....	....	...	186	93	93	....	....	....	200	149	51	405	23

	Distribution Lines (Cont'd.)								*Distribution Substation Capacities in Kv-a*					*Investment*	
	Distribution Transformers	*Street Lighting*	*Services*	*Meters*	*Primary Customers' Installations*	*Total Cost*				*Rated*	*Firm*	*Reserve*	*Peak Load (Kva)*	*Per Kw. of Firm Rating*	*Per Kw. of Peak Load*
						Total	*Firm*	*Reserve*	*Plus 10.5%*				*Induction Regulator*		
Typical Load Area	$648	$356	$385	$652	$44	$22,513	$19,555	$2,958	$24,878	156,000	117,000	39,000	167,000	85,000	$213	$293
Large Industrial Substation Area	185	....	102	293	25	6,783	5,971	812	7,494	43,100	38,300	4,800	63,900	29,000	195	258
City Lighting Substation Area	195	....	61	122	2	1,838	1,603	235	2,030	12,000	9,000	3,000	15,200	6,400	225	318



No data available from which to estimate total of customers' connected apparatus.

Sample Chart XII—Capacities and diversities of a typical Metropolitan Electrical System

tribution substation is determined and expressed in dollars per kilowatt of circuit demand. The total investment may also be compared to the number of each class of customer served.

Total Investment by Distribution Substations and by Load Areas

By combining into a single table the total investment chargeable against each distribution substation together with its firm capacity and the peak load served, we have a very interesting and accurate index of what might be termed the investment efficiency for each distribution substation on the system. It will bring out the weak spots and, together with the operating records, serve as an invaluable guide in future situations.

A similar table should be prepared for each of the load areas.

Sample Chart XI illustrates the result.

System Capacities and Diversities

From the system analysis outlined, a diagram similar to Sample Chart XII may be prepared. It is self-explanatory.

VII—Methods of Investment Control in Making System Extensions

Having established an investment picture of the existing system and made maximum use of the system as it stands, the next step is to develop methods of applying what we have learned to proposed system extensions.

The general rules for extensions to the Bulk Power System, the Subtransmission Lines and the Distribution Substations are—

1. From the operating record of outages, determine what reliability is actually required.
2. Determine the firm rating of the various alternative methods.
3. Select the method which gives the lowest net investment over the period of usefulness.

The following example will illustrate. Assume an application for industrial service at a point two miles away from a subtransmission line loop, the load being too large and remote to be served from existing distribution lines. Let us analyze (see Fig. XII-A) the alternative courses open basing them on the outage data given in Table I.

OUTAGE EXPECTANCY

Cause	*No. Outages Per Year*	*Duration Per Outage*	*Duration Per Year*
*Distribution Line (1 mile in length—all overhead)	1/22	50 min.	2 min. 16 sec.
Substation	1/30	20 min.	40 sec.
Subtransmission	0	0	0
Bulk Power	1/20	40 min.	2 min.
	1/8		5 min.
Cost of Installation			$6,000

*Where there are similar lines in the same general class of territory their specific outage records should be used instead of average values.

From the examples in Figure XII-A it is evident that any provision in excess of Method II is decidedly in the area of diminishing return. It is very questionable if the $26,800 difference between Methods II and III is justified to reduce five one-minute outages per year to two and three-quarters one-second outages.

As another example (see table at lower left) let us assume an industrial load too large or too fluctuating to be served off a regular distribution circuit and located one mile from an indoor city type industrial substation.

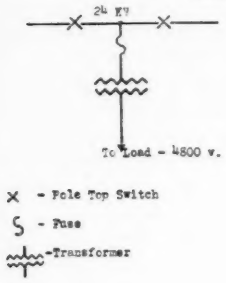
It is very evident in this case that we would not be justified in providing any throwover service to such a customer, since, practically speaking, he will suffer a single forty minute outage about once in eight years.

Now let us turn our attention to the smaller additions made to existing distribution lines, the aggregate of which will be the distribution system of tomorrow. These additions to investment are so many that they could not possibly be scrutinized by the executives. Therefore, rules and specifications must be set up as guides to those making the day to day decisions. These rules and specifications are based on certain standards of service—more particularly service voltage tolerances, lamp flicker tolerances and assumed load densities. Too often these standards of service are set with scant regard for the cost or even for the possibility of meeting them at all.

To appreciate the importance of carefully determined standards, let us consider first the elements of the distribution system and how they are affected by standards and specifications.

In no other part of the electrical system is the investment so largely determined by extraneous conditions as in the distribution system. Poles, fixtures and primary wire, which comprise approximately 35 per cent of the investment, are almost entirely independent of the load carried. Only in the transformers, secondary mains, service wires and meters is the investment proportional to the number of customers and to load. The investment in service wires and meters, comprising 15 per cent of the line investment, is largely fixed by the number of customers. Therefore, only the transformers and secondary mains may be altered to give minimum cost. However, these are of no small importance as they comprise some 50 per cent of the investment in distribution lines and total nearly three billion dollars for the entire country.

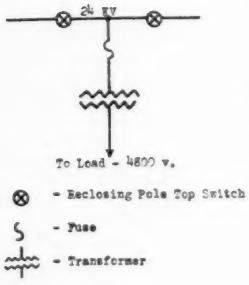
METHOD I. Single Tap Substation



Cause	No. Outages	Duration Per Outage	Duration Per Year
Substation	1/6	2 hrs.	20 min.
Subtransmission lines (14 miles between auto-breakers, plus two mile tap)	5	4--1 min. 1--30 "	¾ min.
Bulk Power	1/20	40 min.	2 min.
	5.22		56 min.

Cost of Installation - $20,000

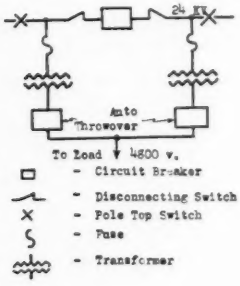
METHOD II. Reclosing Pole Top Switch Station



Cause	No. Outages	Duration Per Outage	Duration Per Year
Substation	1/6	2 hrs.	20 min.
Subtransmission Lines (14 miles between auto-breakers, plus two mile tap)	5	1 min.	5 min.
Bulk Power	1/20	40 min.	2 min.
	5.22		27 min.

Cost of Installation - $22,000

METHOD III. Single Circuit Breaker Substation with Automatic Load Throwover



Cause	No. Outages	Duration Per Outage	Duration Per Year
Substation	1/6	2 hrs.	20 min.
Subtransmission Lines (Includes four mile loop)	2.75	1 sec.	2.75 sec.
Bulk Power	1/20	40 min.	2 min.
	2.97		22 min.

Cost of Installation - $48,800

Figure XII-A

Figure XIII illustrates the economic balance existing between distribution transformers and secondary wire size expressed in cost per thousand feet of line plotted against secondary wire size. These curves take into account not only the investment but the losses as well. The effect of losses is to move the curve upward, that is, to raise the cost, but it does not materially change the shape of the curve nor shift the low point with respect to wire size. Losses therefore do not greatly affect the choice of secondary wire size.

Figures XIII, XIV, XV and XVII and Table XVI are all based on 2½ per cent voltage regulation in the secondary mains. The reason for this is that the total permissible voltage variation at the customer's service entrance is set at six per cent, which is spread over the circuit as follows: primary mains, 1¼ per cent; secondary mains, 2½ per cent; service wire, 1¼ per cent; miscellaneous, 1 per cent. Transformer drop is considered to be a constant value for all sizes, since 100 per cent loading is assumed. Therefore, it can be compensated for by the substation regulator and does not appear in the permissible range.

It might also be pointed out that while 10c. weatherproof wire has been employed in the illustrations, the use of higher-priced wire will not materially alter the conclusions. Figure XIII illustrates the effect of wire price.

Figure XIV indicates the effect of 5 per cent voltage regulation as compared to 2½ per cent for load densities of 10 kw., 30 kw. and 70 kw. per thousand feet of line. It is very apparent that we cannot afford to maintain other than very good voltage regulation, particularly when the satisfactory operation of ranges, water heaters and heating devices generally are so largely dependent upon it.

Figure XV illustrates the limitation imposed by lamp flicker. You will note that for 10-kw. load density lamp flicker imposes a more strict limit than does voltage regulation. At 30-kw. density, flicker is the limiting factor for No. 2 wire and smaller, while for 70-kw. density, voltage regulation is the limiting factor.

The limiting case in lamp flicker is the starting current of refrigerator motors. We have designed for a two-volt limit on the banked transformer city circuits because it could be easily done where capacity for rather large growth

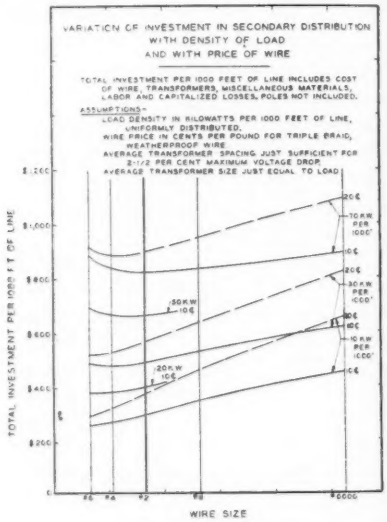

VARIATION OF INVESTMENT IN SECONDARY DISTRIBUTION WITH DENSITY OF LOAD AND WITH PRICE OF WIRE
TOTAL INVESTMENT PER 1000 FEET OF LINE INCLUDES COST OF WIRE, TRANSFORMERS, MISCELLANEOUS MATERIALS, LABOR AND CAPITALIZED LOSSES. POLES NOT INCLUDED.
ASSUMPTIONS-
LOAD DENSITY IN KILOWATTS PER 1000 FEET OF LINE, UNIFORMLY DISTRIBUTED.
WIRE PRICE IN CENTS PER POUND FOR TRIPLE BRAID, WEATHERPROOF WIRE.
AVERAGE TRANSFORMER SPACING JUST SUFFICIENT FOR 2-1/2 PER CENT MAXIMUM VOLTAGE DROP.
AVERAGE TRANSFORMER SIZE JUST EQUAL TO LOAD
TOTAL INVESTMENT PER 1000 FT OF LINE
WIRE SIZE

Figure XIII

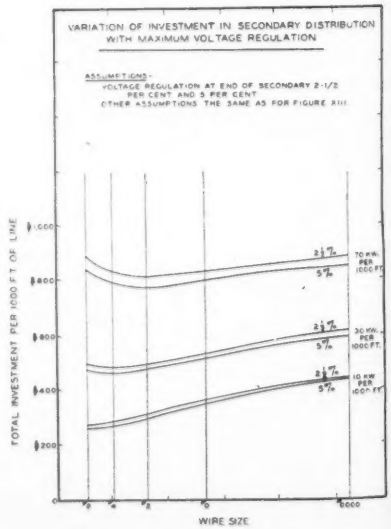

VARIATION OF INVESTMENT IN SECONDARY DISTRIBUTION WITH MAXIMUM VOLTAGE REGULATION
ASSUMPTIONS-
VOLTAGE REGULATION AT END OF SECONDARY 2-1/2 PER CENT AND 5 PER CENT
OTHER ASSUMPTIONS THE SAME AS FOR FIGURE XIII
TOTAL INVESTMENT PER 1000 FT OF LINE
WIRE SIZE

Figure XIV

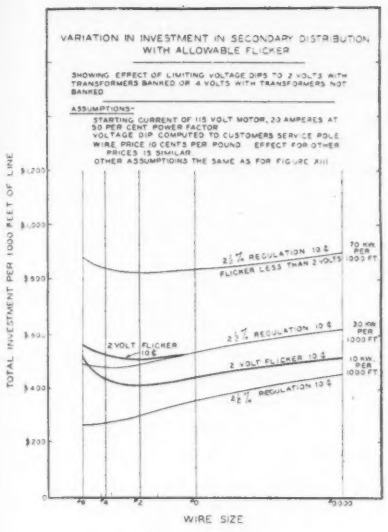

VARIATION IN INVESTMENT IN SECONDARY DISTRIBUTION WITH ALLOWABLE FLICKER
SHOWING EFFECT OF LIMITING VOLTAGE DIPS TO 2 VOLTS WITH TRANSFORMERS BANKED OR 4 VOLTS WITH TRANSFORMERS NOT BANKED
ASSUMPTIONS-
STARTING CURRENT OF 115 VOLT MOTOR, 23 AMPERES AT 50 PER CENT POWER FACTOR
VOLTAGE DIP COMPUTED TO CUSTOMERS SERVICE POLE
WIRE PRICE 10 CENTS PER POUND EFFECT FOR OTHER PRICES IS SIMILAR
OTHER ASSUMPTIONS THE SAME AS FOR FIGURE XIII
TOTAL INVESTMENT PER 1000 FEET OF LINE
WIRE SIZE
2½% REGULATION 10¢
FLICKER LESS THAN 2 VOLTS
70 KW PER 1000 FT
2 VOLT FLICKER 10¢
2½% REGULATION 10¢
30 KW PER 1000 FT
2 VOLT FLICKER 10¢
2½% REGULATION 10¢
10 KW PER 1000 FT

Figure XV

is assumed. For suburban circuits where transformer banking is impracticable, we must content ourselves with a four-volt limit. The reasons for this are very apparent in Table XVI. (The voltage values given must be doubled for operation with unbanked transformers.) You will note that if you wished to limit flicker to two volts, your design for load densities 100 kw. and less will be governed by flicker limits rather than by regulation and hence will be more costly. Reference to Figure XV will show how the cost for low load densities is affected by limiting the flicker even to four volts. Obviously, such expenditures cannot be justified.

Returning to Figure XIII, you will note that it shows complete cost curves for load densities of 10 kw., 30 kw. and 70 kw. per thousand feet of line and for 10c. and 20c. weatherproof wire for each load plotted against secondary wire size. There are also shown the 20 kw and 50 kw loads for 10c. wire. Present-day load densities in well built up residential territory will run from 15 kw. to 20 kw per one thousand feet of line, whereas the 70-kw. density corresponds roughly to an electric range, a refrigerator and an oil burner for every customer.

All things considered, the practical solution is to adopt No. 2 secondary wire, since it will lie very near the low cost point for all load density from 20 kw. to 70 kw., and will not be a bad balance even at 100-kw. density. Figure XV and Table XVI also show that acceptable lamp flicker conditions will be had with this wire size. You will also note that a range of copper prices has comparatively little effect on the size of secondary wire. *Therefore, since the size of secondary wire becomes a fixed value, it is evident that control of transformer and secondary investment lies very largely in* the judicious location and loading of the transformers.

It, therefore, pays to assume some rather heavy density for future load, say 50 kw. to 60 kw., and make system planning maps for the growing parts of the system showing permanent transformer locations and primary wire size. Figure XVII shows the extent to which the assumption of a fixed transformer spacing departs from the ideal spacing for minimum investment. You will note that the investment difference is not large enough to invalidate the assumption. Initially, transformers of a size to carry the load likely to occur in a year or two can be hung in every alternate location. These sizes can then be increased as the load grows and the intermediate ones added as necessary. *Such a method will give minimum cost for transformers and secondary.* When it is considered that transformers represent about one-third the total investment in distribution lines, the importance of carefully watching the use of transformers can be appreciated.

Figure XVII shows the investment at 100 per cent transformer loading. For a 20-kw. load density, 15 kv.-a. transformers spaced at 700 ft. are adequate. If, due to liberality or carelessness, the next larger size transformer, 25 kv.-a., is used at the same spacing, the capacity is raised to 35 kw. per one thousand feet and the cost raised $100 per one thousand feet. This example will serve to illustrate the importance of careful selection of transformer sizes.

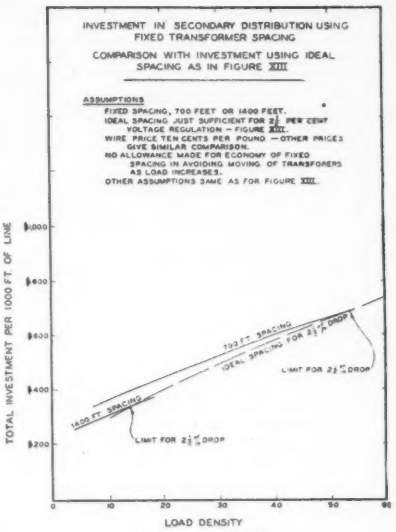

INVESTMENT IN SECONDARY DISTRIBUTION USING FIXED TRANSFORMER SPACING
COMPARISON WITH INVESTMENT USING IDEAL SPACING AS IN FIGURE XIII
ASSUMPTIONS
FIXED SPACING, 700 FEET OR 1400 FEET.
IDEAL SPACING JUST SUFFICIENT FOR 2½ PER CENT VOLTAGE REGULATION — FIGURE XIII.
WIRE PRICE TEN CENTS PER POUND — OTHER PRICES GIVE SIMILAR COMPARISON.
NO ALLOWANCE MADE FOR ECONOMY OF FIXED SPACING IN AVOIDING MOVING OF TRANSFORMERS AS LOAD INCREASES.
OTHER ASSUMPTIONS SAME AS FOR FIGURE XIII.
TOTAL INVESTMENT PER 1000 FT OF LINE
700 FT SPACING
IDEAL SPACING FOR 2½% DROP
LIMIT FOR 2½% DROP
1400 FT SPACING
LIMIT FOR 2½% DROP
LOAD DENSITY

Figure XVII

Design and Standardization of Distribution Line Structures

While the investment in poles, fixtures and primary wire is largely independent of the load or the number of customers served, there is a considerable amount to be saved, both in material and labor, by the simplification and standardization of line construction. In one company the result was a reduction of fifty per cent in line material items stocked. While it is difficult to estimate, a very real saving was also had from the uniform and simple standardized construction of the more common assemblies, such as transformer poles, dead ends, corners, etc.

It also pays well to carefully engineer each job, making a specific layout if the job is of any size.

Another source of real saving is to adapt the standard of construction to its particular purpose as far as local ordinances and physical limitations will permit. Low cost farm lines are an example of what can be done in this direction if one is not too much bound by tradition.

Probable Trend of Distribution System Investment

A summary of the larger factors influencing distribution system costs appears in the next column.

TABLE XVI—FLICKER FOR TRANSFORMER SIZES AND SPACINGS USED TO GIVE 2½% DROP—(FIGURE XIII)

(Value Given in Volts)

Transformers Banked—(For unbanked Operations, Multiply by Two)

	Load Density (Kw. per 1000 Ft.)									
Wire Size .	*10*	*20*	*30*	*40*	*50*	*60*	*70*	*80*	*90*	*100*
No. 6	4.3	2.9	2.3	1.9	1.7	1.6	1.5	1.4	1.3	1.25
No. 4	3.5	2.6	2.1	1.8	1.6	1.5	1.4	1.3	1.2	1.15
No. 2	3.4	2.3	*1.9*	1.7	*1.5*	1.4	1.3	1.2	1.2	*1.1*
No. 0	3.3	2.3	1.9	1.7	1.5	1.4	1.3	1.2	1.2	1.1
No. 0000	3.3	2.3	1.9	1.7	1.5	1.4	1.3	1.2	1.2	1.1

3 volts banked, 6 volts not banked — 2 volts banked, 4 volts not banked — 1½ volts banked, 3 volts not banked

Those tending toward reduced costs are—

1. Standardization of materials and their application should show an appreciable reduction over lines built at random.
2. The accurate engineering of transformers and secondary copper should show a very real saving.
3. The intelligent engineering of each construction job is important. Much money can be wasted by "rule of thumb" methods.
4. The intelligent differentiation between the requirements of city, village and rural service.

Those tending toward increased costs are—

1. The growing tendency of municipalities to force lines off the main thoroughfares, often underground.
2. The blind following of fads and fashions in distribution practice without regard to the necessities of the case.

It seems probable that the factors tending to raise costs, particularly in city distribution, will largely offset those tending to lower them, and that will most certainly be true unless we are very careful to avail ourselves of all the advantages of radial distribution before adopting the much more costly multiple feed methods. However, we should not belittle the savings outlined because they may be outstripped by the increasing requirements. Those savings are very real and are a call to distribution engineering of the first order.

Conclusion

We have attempted to show how accurate investment control is dependent on the wise handling of system extensions, and the important part which may be played by operating outage data, service standards and investment analyses in guiding the day to day decisions on which these system extensions are based.

We would not have you think that all of the methods set forth in this paper are firmly established. For instance, the methods of investment analysis are those set forth in a preliminary report of the late Power Systems Engineering Committee, N.E.L.A. They could profitably be further studied and agreement reached as to their debatable features. Though incomplete these methods are infinitely better than none.

The further study of operating outage data and its use in evaluating system extensions should also be carried out. It is a comparatively new subject.

DISCUSSION OF MR. DEAN'S PAPER

By B. L. HUFF*

Commonwealth and Southern Corporation

I am sure we will all find in Mr. Dean's paper much that will assist us in exercising control of investment charges, the importance of which have been forcibly emphasized in the last few years to any who may have formerly lacked appreciation of the subject.

Mr. Dean specifically mentions three reasons for increasing system investments:

1. Load Growth
2. Voltage Regulation
3. Lamp Flicker

and a fourth reason of extreme importance which he stresses all through his paper is that of Capital Expenditures solely to provide increased reliability of service.

I wonder if it is generally realized what considerable sums may be spent for reliability alone if sufficient consideration is not given to just how much improvement can be obtained and at what cost?

Investments for reliability of service may take many forms, such as:

Duplication of Facilities
Spare Equipment
Increased Line Insulation
Automatic Reclosing Equipment
Protective Equipment, etc.

It is often difficult to sift out those items which are necessary from those which are merely considered desirable because some annoying circumstance occurs which perhaps, is not of a recurring or basically serious nature.

Expenditures for load growth are usually obvious and require no engineering analysis to determine their necessity.

Improvements for voltage regulation demand a little more nicety of judgment as it is possible to carry expenditures for this purpose to extremes in striving for too near an approach to perfection.

Lamp flicker may be due to conditions in the customer's wiring as well as conditions on the utility's system and sufficient analysis of troubles from this source should be made to determine where the difficulty lies before incurring any investment in an attempt to correct something which is beyond our control.

Reliability of service, or rather degrees of unreliability of service, require analysis to determine whether or not corrective measures are possible and necessary, and if so, to what extent they should be applied.

There usually is an obvious remedy which may be applied to unreliable service conditions at comparatively small cost if the degree of correction is not carried to extremes.

Serious thought must be given in each case and for each system as to what constitutes a reasonable standard of reliability and regulation. On the answer depends our investment, our fixed charges, maintenance and operating expenses and consequently the cost of energy to the consumer.

Is the lamp flicker which annoys an illuminating engineer of any real consequence or annoyance to the particular user affected?

Are interruptions of supply, if not too long or too frequent, of great concern to the power user if no vital manufacturing process is affected?

Service which from the standpoint of interruptions might be classed as substandard in a highly developed metropolitan area would be entirely satisfactory in a smaller community. Many office buildings in our larger cities house thousands of occupants and are supplied with electrical service for different uses on a scale comparable to a small city. The interruption of such a vital supply would, to say the least, cause considerable inconvenience, annoyance and confusion.

The very fact that such loads are so heavily concentrated permits and justifies making the necessary investment to protect the service. An attempt to safeguard the supply to smaller office buildings in which an interruption is of less consequence would produce an investment all out of proportion first, to the return thereon and second, to the necessities of the particular case.

Voltage regulation should not ordinarily exceed certain maximum limits, but a limit which is satisfactory for a motor load is not good enough for lighting and what is good enough for lighting may be entirely unsatisfactory for some industrial loads.

It is impossible to establish one uniform standard of service for all customers as it would necessarily have to satisfy the most extreme requirements and would work to the disadvantage of those whose needs are less exacting.

It all resolves itself into the question of the requirements of the customer. He is penalized if the standards adopted are too high and too costly for his individual needs.

Decisions on the methods of construc-

*Read by Mr. W. H. Sammis.

tion to be used to secure the lowest cost in any particular case must be made with a thorough understanding of local conditions and the requirements of the individual loads. Too often there is a desire to install in the average community some system which has been given wide publicity, or some particular type of construction which has proved well suited in our larger centers of population where there are heavy loads and densities, only to find that simpler construction will result in a more reasonable and justifiable investment and a degree of reliability suitable for the particular conditions to be met.

On the other hand, a low first cost installation may be made which requires excessive operating expense or maintenance when a more expensive installation would show a greater overall economy, although this is not to be construed as meaning all low cost installations are necessarily costly to operate and maintain.

The control of service standards and investment is a problem which particularly concerns operating and design engineers as their judgment will influence the final results. If we avoid striving for record operating performance which may cost too much to achieve, but rather concern ourselves with carefully considered service standards suited to our own particular customers' conditions and weigh investments and operating costs together, keeping them on a level which will produce the greatest overall economy, we will not go far astray.

DISCUSSION BY MERRILL DE MERIT

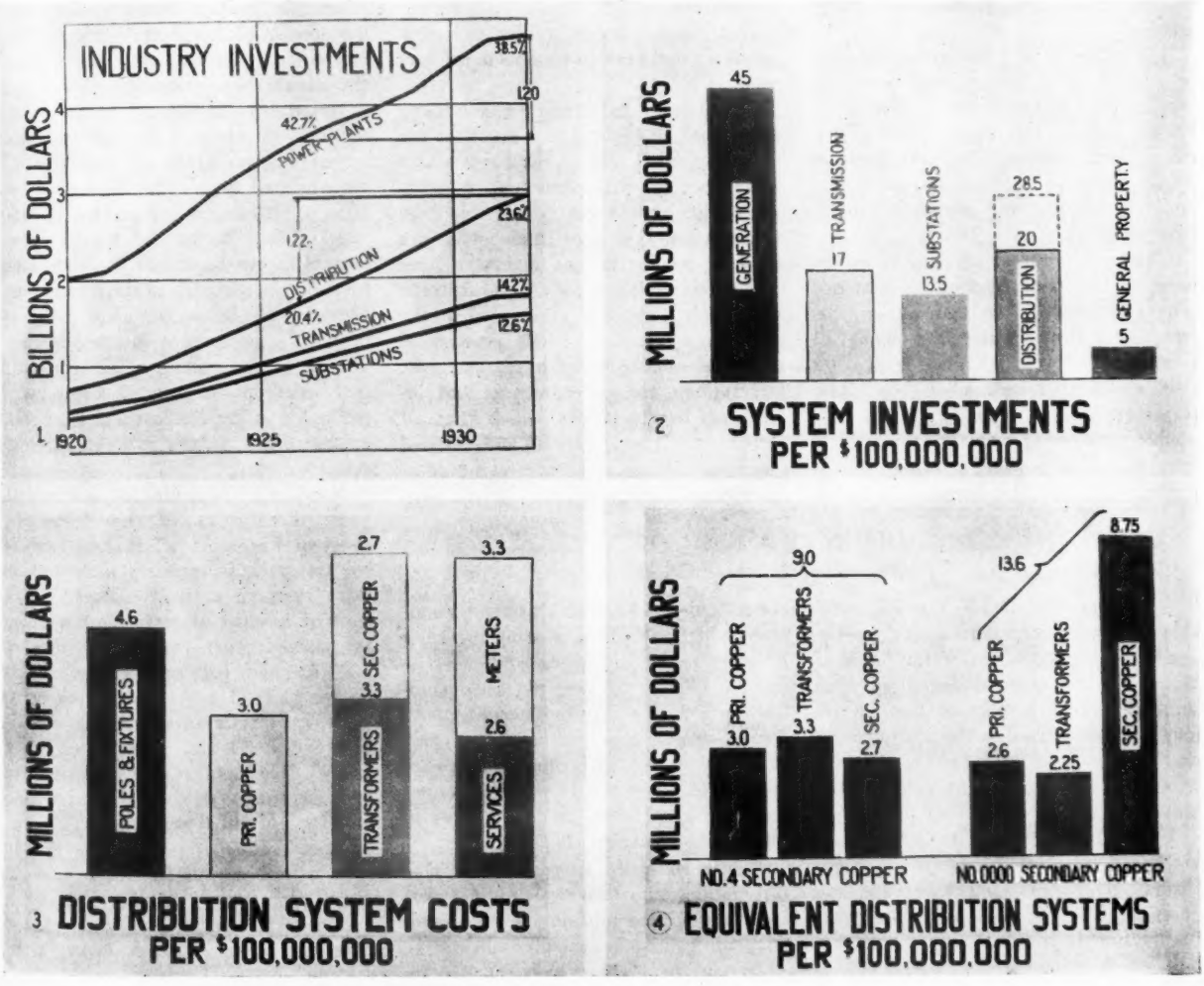
West Penn Electric Company

When I was asked to discuss Mr. Dean's paper, time was not available to compile comparative figures for the West Penn companies, and so I will amplify a part which Mr. Dean has given due prominence, but which generally is not given adequate executive consideration.

As Chairman of the former Overhead Systems Committee, N.E.L.A., I made an analysis of the parts of the overhead electric plant with the idea of directing effort toward that part which costs the most money—the distribution system.

As an example, the plant expenditures of one of our companies for transmission for a given period were $800,000, and for distribution, $1,500,000. The ratio of the number of jobs was 33 to 1100. Usually under such conditions the importance of the greater distribution expenditure is lost due to the small size of the elements.

In trying to locate men of ability and training to work out the distribution problems, it was found that in many cases men on distribution work who had shown exceptional ability had been transferred to positions considered to be more important.



Charts 1, 2, 3 and 4 for Mr. De Merit's discussion

Chart No. 1 shows the expenditures for the different types of plant as reported in the *Electrical World* for the years 1920-1932 inclusive. Distribution is a major part of the total plant investment, being 23.6 per cent of the total, and since 1926 the average annual expenditures for distribution have been higher than those of any other part of the plant including the generating stations.

Chart 2 shows the division of one hundred million dollars of plant investment for a group of companies with scattered territory, and a high proportion of wholesale power. Generating station cost is the largest item and distribution, which is $20,000,000, is next. The transmission system is $17,000,000. The dotted line shows distribution investment for a company having densely populated territory, with distribution and transmission costs, respectively, of $28,500,000 and $17,000,000. This tends to indicate that distribution is worthy of as much attention as transmission.

The influence of transmission concepts on distribution design and economic studies has resulted in one or two well-known comparisons based on the primary plant without due consideration being given to the transformers, secondaries, services and meters. This is most illogical.

Chart 3 shows the investment in the parts of the same distribution systems. The primaries of the distribution system under consideration are about 20 per cent 6900 volt; 15 per cent 2300 volt, and 65 per cent 4000 volt. The transformer and secondary costs are double the cost of primaries, and about equal to cost of services and meters.

Regardless of the preponderance of transformer and secondary investment, some may comment that this is of little importance, because nothing can be done about it. Those who have made an intensive study of this situation realize that this is not the case.

Chart 4 shows the costs of primaries, secondaries and transformers of an actual plant in which No. 4 secondaries are used and of the same plant designed with 4/0 secondaries. Figures are per million dollars of total plant (including miscellaneous and generation). There is a difference between the two designs of $4,600,000, which is equal to 166 per cent of the total primary copper investment.

The chart illustrates only first cost. The assumption is made that a correct system of progressive secondary design is followed in each case. Over a 15-year period, the usual method of rebuilding with increasing load would result in an additional difference of the same order in operating and R & R expenditure.

Distribution design studies and comparisons should not be limited to primary costs.

Distribution planning and design should not be slighted as a result of the relatively small size of the parts which make up its total; distribution economical studies should not be controlled by transmission concepts; men who are working on distribution and who have considerable ability should be encouraged by an executive realization of the importance of distribution; economical studies should be based on actual tests, interruption and other records and intelligent determinations which take all factors into consideration, and isolated experience, inertia and tradition should be discounted.

DISCUSSION BY A. E. SILVER*

Electric Bond & Share Co.

I consider Mr. Dean's paper a valuable and timely contribution to the problem of giving more service for less dollars. His open-minded and progressive thinking carries conviction that efforts may well be directed to the readjustment and simplification of practices for the new load era that lies ahead for the industry.

Under the caption, "The Outage Record as a Background for Decisions," Mr. Dean presents convincing counsel for sane analysis of service needs as an approach to investment control. He points out the difficulty, which we all have encountered when critically analyzing the cause of some recent disastrous equipment or station failure, of keeping one's equilibrium against excessive expenditures to insure against the return of that particular trouble. An equally thorough analysis of the extent to which customer service was impaired, usually will aid in maintaining balance.

Figure II, seems an excellent graphic illustration for studying customer service interruption and outage as a yardstick for gaging system investments.

It must be realized that the data in Figures II and III present the picture as analyzed for the Detroit area. Similar charts for other areas in the country would show variant relations. However, for the purpose of this discussion, I shall allude to Figure II as if representative of conditions generally.

As added emphasis to one portion of the picture that Mr. Dean has drawn, if I may go into some further detail, I would like to offer certain ideas in regard to the application of the principles embraced in Figure II. I shall confine myself to the customer interruption graph at the left hand of the chart, marked "Suburban," as probably representative of a larger portion of the load areas of the country than the one at the right.

First permit me to say a word of definition for the terms, "interruption," "duration" and "outage". I prefer to think of "interruption" as the broad term indicating occurrence without reference to "duration," as Mr. Dean has done in his vertical scale; also to use "duration" in the sense that Mr. Dean has done in his horizontal scale. I think of the term "outage" as combining both the number of interruptions and their duration. Outage may be called the product of these two figures, represented by the areas embraced by the rectangles of the chart. When a circuit trips a certain kw. of service is *interrupted,* but the *outage* would be expressed in kw.-hr. as the product of this kw. and the *duration* of the interruption. Outage may be looked upon as an approximate measure of interruption seriousness to the customer. The momentary interruption even of large kw. is negligible in kw.-hr. lost and is of small inconvenience to the average suburban customer.

Now, as an example, let us scrutinize those three items of the "suburban" chart of Figure II which represent 24-kv. transmission, primary lines and primary fuses respectively. Rated on the basis of number of service interruptions per customer per year, the figures are 1.8, 1.9 and 0.1 respectively. Rated on the basis of average duration of the customer service interruptions, the figures are 9, 24 and 75 minutes respectively. The outages, taken as the areas of these rectangles to these scales, come out 16, 46 and 8 respectively. Judged on these ratios of outage, the primary lines afford essentially three times as much opportunity for effecting gain to customer service as the next ranking offending item, that of 24-kv. transmission.

As regards the primary distribution

* Read by Mr. Mark Eldredge, Memphis Power & Light Company.

line, in the past, I believe, engineers have been prone to look for outage reduction principally in the direction of decreasing the number of interruptions, that is reducing the height of the rectangle. To this end insulation levels gradually have been raised, the number of individual circuits has been kept high, parallel or loop circuits with automatic sectionalizing or throwover features have been provided, and other measures applied. I believe that the gain along these conventional lines has reached and perhaps passed the economic point in the law of diminishing returns, at least until practices not now in vogue become available.

When further worth while gain is made in reducing the frequency of primary circuit interruptions, I predict it will come from simple adjuncts to the line insulator that will freely spill the lightning surge without power current flowing in its wake—as an eventuality from the encouraging results already realized experimentally on certain high voltage transmission lines.

Effort in the other direction, that of reducing outage by reducing the duration of interruptions, that is reducing the width of the rectangle, has not, until rather recently, received proportionate attention. The measures being applied are not on the order of reserve or duplicate facilities, but along the line of close and coordinated functioning of facilities already in use. The first objective is to eliminate, or reduce to the practicable minimum, conductor burndowns and insulator breakage, that is, thermal damage from power fault current. These two items are major offenders among the causes of prolonged interruption. To gain this, the fault current must be interrupted quickly enough to prevent a damaging release of heat. Experience is showing that this is practicable and not expensive.

With thermal damage to the faulted primary line prevented by quick disconnection, the next step of gain lies in restoring the circuit to service with the minimum wait. Here again, more recent experience is showing thoroughly advantageous results from fast automatic reclosing of primary feeders. This is being accomplished by adaptation of existing switching and relaying equipment. With continued effort and manufacturing cooperation, there is ample reason to believe that through the further perfecting of these functions, primary distribution circuit disconnections and reclosures can be made sufficiently rapid to produce negligible effect on most suburban service in from 80 per cent to 90 per cent of the cases of interruption that we are now familiar with.

Now refer to the primary fuse. The chart shows that its effect on outage comes very largely from duration rather than from frequency of service interruptions. Presumably this is because, with few exceptions today, the fuse, when blown, requires the dispatching of a trouble man for manual replacement. If a simple automatic function could be adapted to primary fuse replacement the duration of service interruptions from this cause might be reduced. Unfortunately the primary fuse, as we know it, inherently has only coarse adjustment for some of its essential duties, particularly that of protecting the transformer from overload. Furthermore, it does not lend itself simply and cheaply, to applying the automatic replacement function.

For accuracy and economy, the secondary terminals of the distribution transformer appeal as a logical place to accomplish protection for all troubles of secondary circuit origin. A small and very simple automatic opening and automatic reclosing circuit breaker in the transformer secondary terminals, it is believed, would afford this protection. As a protective measure it would coordinate with the automatic reclosing breaker controlling the primary feeder, probably with the omission of the conventional primary fuse. The satisfactory development of such a device should not present any considerable difficulty to the manufacturer and I predict that soon it will be tried out and make a place for itself.

While I have offered these two applications from the approach of reduced investments, it is believed that the net effect also would be some reduction of operating costs. This would come in two ways, as a result of simplification of facilities and as a result of reduced maintenance because of less thermal damage to lines and equipment.

I have made no mention of the secondary network system that is proving advantageous in the dense urban load areas. Its simplified and economic adaptation for overhead installation in some heavier suburban load areas appears not improbable.

Analyses of distribution transformer and distribution line troubles from the operating experience of a substantial number of Electric Bond & Share Company client companies, together with published data of other operating companies, is the foundation for the belief that by the foregoing approach, present customer service interruptions in suburban areas, and in lesser degree rural areas, originating outside of the customers' facilities, can be so controlled, with economy, as to constitute relatively small outage.

To summarize, these two specific applications, aimed at reducing duration rather than frequency of service interruption, have been cited as one effective means of holding down investment under the customer service yardstick advocated by Mr. Dean. The investment economies will come from the simplification and greater dependability of facilities. With the increased service dependability of the simple radial distribution line a higher use factor, and a reduced urge for reserve or duplicate facilities and protective accessories, can be developed. In other words, minimizing duration of customer service interruption by more accurate functioning of present facilities will permit taking heavier loads on these facilities before the necessity of investing in extensions.

DISCUSSION BY H. W. EALES

Byllesby Engineering and Management Corporation

The opportunity to review Mr. Dean's paper is a welcome one. It abounds in evidence of a comprehensive plan well thought out and applied. It seems a bit presumptuous to comment on it on short notice. The comments are given, however, by invitation.

I recommend that the paper not only be read but studied carefully by all system development engineers. In approaching such study, I recommend further that they first read the paragraph giving the purpose of paper (Sec. II), and then read the conclusion on page 122. By doing so, the reader will in my judgment have the clearest perspective in his perusal of the balance of the paper.

In the short time since the paper has been available, it has not been possible to make as close an analysis as I should eventually like to make. It has also not been possible to confer with the author on some doubtful points before preparing this discussion.

Regardless of whether as a result of such later study some differences of opinion with the author may arise, I wish to say at the outset that the paper is certainly a progressive effort. It is enlightening in other respects.

In these days of super-specialization, it is quite customary to see all technical matters relating to generating stations referred to a mechanical, a hydraulic or an electrical engineer, or combinations of these specialists; matters relating to a substation to an electrical engineer an "inside plant" or "outdoor" engineer as the case may be; a transmission problem to a transmission engineer and a distribution problem to a distribution engineer, the latter one of several varieties, depending upon whether the system is overhead or underground, etc., etc. In this paper, we see a comprehensive attempt to analyze the effects of outages and service standards on all branches of the power company's entire physical property (and plant) on its investment in that plant.

While Mr. Dean has derived a number of constants or factors from statistical records of outages of all sorts on all parts of the system, and has outlined methods of using these factors in determining the need for improvements or extensions of parts of the system, he has in my judgment very wisely refrained from attempting to derive a mathematical expression of letting "X" equal the answer. As was implied by Mr. Dow and others yesterday and on other occasions, it is still impossible to substitute a formula for experience and the judgment derived from it.

The author has arranged parts of the total physical system into groups and parts which are clearly defined in the paper. It is not clear, however, just how the segregations of cost for these groups have been derived.

For this latter reason, the writer wishes to sound a note of caution to readers as to their unqualified acceptance of certain unit cost figures mentioned in the paper both as to their application to the Detroit system and for purposes of comparison with other systems. This comment is intended in the interest of avoiding misinterpretation, not that I have any fault to find with the figures themselves.

The paper contains a number of tables of investment costs as, for example, Chart VII which gives "bulk power and load area investment chargeable against Substation No. 1." If permissible, I recommend to the author that the chart be supplemented by a map defining the area and a condensed connection diagram indicating the nature of the electric supply. This supplementary information would, I think, assist others in their understanding of the author's applications and in their comparisons with other types of systems and other conceptions of the system set up than the ones described by the author.

The writer also recommends that the author delete the second paragraph of the footnote at the bottom of the third column on Page 117. The meaning of this paragraph is not entirely clear to me, and it also does not seem to be entirely relevant to the main subject of the paper. At any rate, as worded, the author lays himself open to controversy as the point stated is not proven.

Again, it seems to me wise for the author to edit the text in the last two full paragraphs of the third column of Page 117 somewhat so that the statement about operating transformers with ungrounded neutral will not stand out as an implied recommendation. From the standpoint of safety to life and property, such a recommendation might be debatable.

On Page 116, second full paragraph, I think it would be desirable to define the term "peak load," i.e. maximum half-hour load, or whatever period is referred to.

In the examples in Sample Charts XI and XII, I think the transformer capacities should be stated.

The factors discussed in the paper embrace many other elements of system design affecting the system investment from an outage and service point of view. Since the author has been so bold as to cover the entire physical plant, as previously mentioned, I think it would add materially to the value of the paper if other physical factors having a bearing on the investment control should also be included. At this time, it occurs to me that in addition to the matters discussed the paper might profitably be extended to include a section on the study of "load duration curves" as revealing more clearly than ordinary typical daily load curves, the periods of time over which the various peaks occur.

It would also seem proper to give some emphasis to the matter of controlling load on equipment on a temperature basis rather than on a basis of name plate rating.

Should other points occur on further study, I will be glad to submit them.

CONCLUDING DISCUSSION BY MR. DEAN

Referring to Mr. Eales' discussion:

Mr. Eales has made a number of interesting suggestions which I shall discuss in the order he has made them.

I have outlined in a general way how we arrived at the segregation of costs chargeable to each load area and to each distribution substation. As pointed out in the conclusion of the paper, further detail of methods for segregating investment may be had by reference to the preliminary report of the Investment Study Group of the late Power Systems Engineering Committee, N.E.L.A. This report will give sufficient detail so that a diagram or map in this paper is hardly justified.

The figures in the various sample charts are in no sense typical of the industry as a whole and are given merely to illustrate the method.

I did not realize that the recommendation of ungrounded neutral operation was in any sense implied. The intent was to recommend it for definite consideration and to submit the operating record of our city lines as evidence of its merit.

I realize quite well that there are a number of terms and expressions throughout the paper which are not accurately defined. We did not attempt to make the paper complete in every detail but rather to suggest, often rather broadly, the method of attack, feeling that if the engineers of other companies were more than casually interested, they would discover the necessity for taking account of a number of supplementary factors.

As far as our studies are concerned, we use as peak load the maximum half-hour load reading.

One will discover at once in trying to reason from the basic outage data given in Table I to the facilities required to give adequate reliability in any particular situation, that account must be taken of load duration curves, the fact that during only a fractional part of the year are we likely to encounter system peak loads, and the emergency operation of equipment on a temperature basis. In most instances, it will also be necessary to brush up a bit on one's probability theory. Since all of these factors will be encountered if one attempts to apply the methods of this study, we did not think it worth while to explain them in detail.

Referring to Mr. Huff's discussion:

You will note that we have very definitely refrained from attempting to define adequate reliability, suggesting rather that each system define that for itself after a study of its own operating records. Attempts have often been made to define sufficient reliability without taking account of the cost of securing it. If the

(*Continued on page* 132)

COOPERATIVE STUDIES FOR JOINT USE OF WOOD POLES

Early in 1932 a power company in the south received a request to supply additional power in connection with the rebuilding of a broadcast station. The broadcast station was located about 15 miles from the city and was supplied over a 6.6 kv line. This line, for a considerable part of its route, was in collinear construction with telephone local cables. The lines were constructed a number of years ago and the situation was not considered entirely satisfactory.

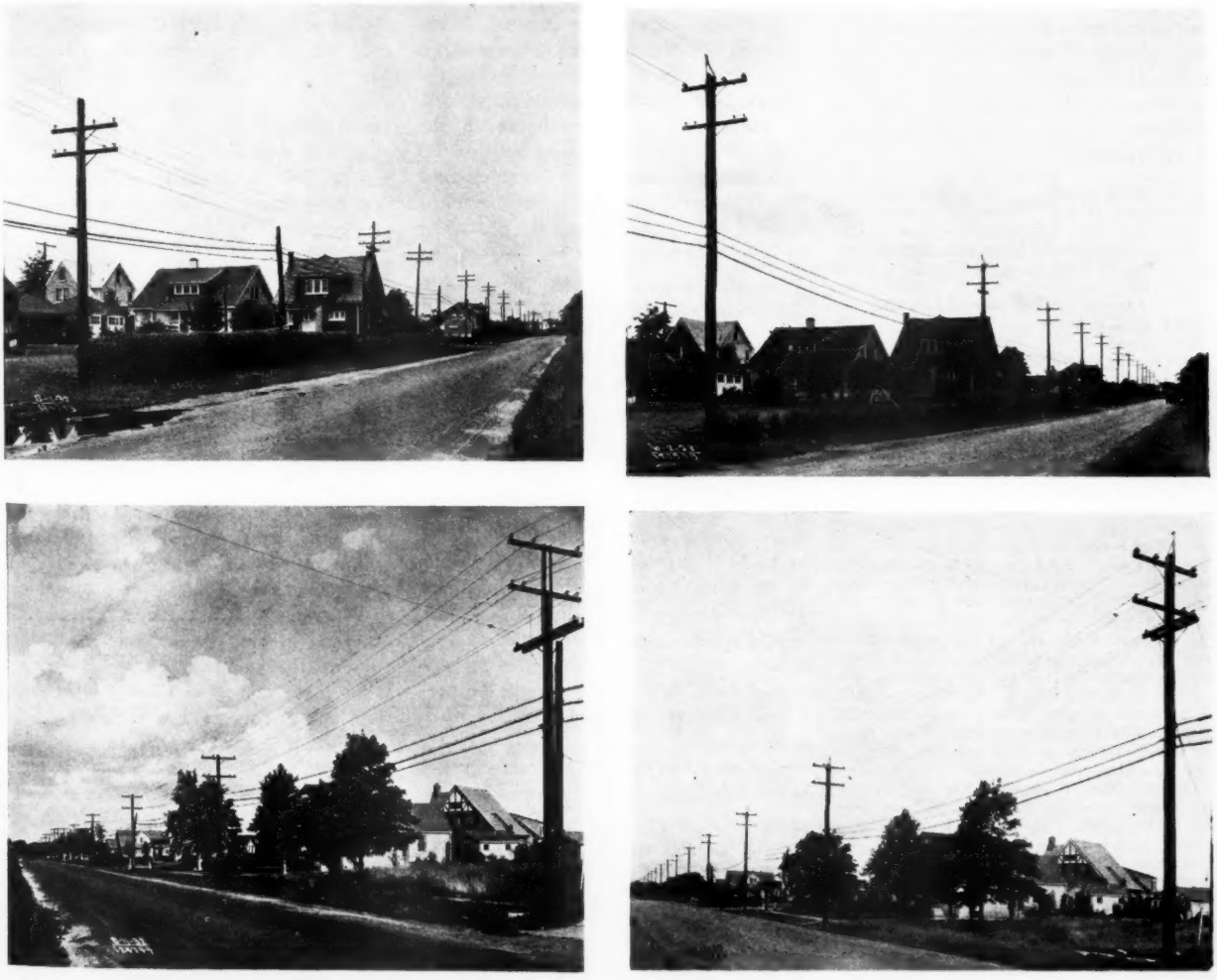
In order to supply the increased power to the broadcast station the power company deemed it advisable to use 13.2 kv. Rebuilding the old line as a 13.2 kv conflict, would make the situation less desirable than the existing situation. Moving this line to the other side of the highway would require an increased expenditure of at least $7,000, and involve considerable right-of-way difficulties with the Highway Department and with other utilities. The use of an entirely separate route would have cost approximately $25,000 additional.

Cooperative Study

A cooperative study was made of this situation in light of the facts which have been developed by the Joint Subcommittee on Development and Research relating to the safety features involved in joint use at the higher voltages. In this situation it was found that the impedance conditions for both power and telephone circuits were favorable from a standpoint of readily providing adequate protection to the communication circuits in case of contact. The power line was supplied from a station bus where a grounding bank was installed. In addition the telephone cable sheaths were grounded to the underground cable and the power circuits were provided with additional relays to insure prompt disconnection in case of contact.

The collinear conflict has been replaced with a joint line with a considerable saving in money, and also general improvements of the lines along the highway.

The accompanying pictures, which show the collinear construction and the new joint use line, clearly bring out the improvements in appearance along streets and roads which can be effected by cooperative work between power and communication companies in line construction in many instances.



Improvement in Highway Appearance obtained by Replacing Collinear Power and Telephone Lines with a Single Joint Line

INDUSTRIAL HEATING NEWS

By D. H. GERHARD

Consumers Power Company, Jackson, Mich., Former Chairman, Industrial Heating Committee

MIDGET HEATING UNITS SAVE MONEY FOR A PROMINENT CUTLERY MANUFACTURER

More and more, industrial plants are coming to the realization that process steam for plant operation during the summer months can be displaced by midget heating units at an appreciable saving.

Here's a typical case, a case where the installation more than pays for itself each year. The Goodell Company of Antrim, N. H., a leading cutlery manufacturer, has a large fuel-fired steam boiler to furnish all steam requirements, including building heating and process steam for the various manufacturing processes. During the summer months and even though steam is not required for building heating, it has been necessary to operate the boiler to supply a comparatively small amount of steam for process work.

Mr. Johnson, the plant manager, tells the following interesting story about the application of midget heating units to his equipment:

"The total installed cost to my company was $346.57. I have saved more than that in the first year of operation because my saving in boiler room labor was $292.81 and my saving in fuel was $133.80, or a total of $426.61.

"The heating devices referred to are employed to a considerable extent to provide for an unusually fine finish on our products. By its means, polishing abrasives are maintained in the proper condition to do their work, and the metal surfaces of the products are treated so as to present a highly polished and perfectly clean surface, which is necessary for the best results when etching the trade marks.

"Our thermostatically-controlled glue cooker has proven very satisfactory. You probably know that glue plays a very important part in the cutlery industry. Poor glue, or glue poorly prepared, means a tremendous waste in polishing costs. The use of this equipment has enabled us to prepare and maintain glue at the proper temperature. The savings made cannot be estimated as they are rather far reaching, but you can readily appreciate that special abrasives applied to polishing wheels with under-cooked or over-cooked glue is a very unprofitable method. The loss of production alone from failure of wheels to perform satisfactorily runs into considerable money.

"The heating equipment for the drying closets has given good service and satisfaction. The function of these units is to dry cutlery after it has been immersed in water, as well as to properly cure polishing wheels after they have been set up with glue and abrasives."

The connected loads of the various items are as follows:

Each warming cabinet	2 kw
The glue cooker	5 "
Each water tank	5 "

ELECTRIC HEATING OF WATER FOR WHEAT TEMPERING

Here's another electric heating application just made to order for those summer months when it costs so much money to operate the big steam plant just for a little process steam.

Flour millers tell us that in order to add the utmost zest to their product the wheat should be tempered. This process consists of adding about 3 per cent moisture to the wheat or about 1.8 lb. of moisture per bushel. The water temperature that produces best results is approximately 120 deg. Fahr.

Just see how effectively and simply the Topeka Flour Mills of Topeka, Kan., put an immersion heater to work on this application. They procured a 30-gal. tank and inserted three 5 kw immersion heaters (in tapped holes, through the bottom) and a thermostat. Then connection was made with the power line through a magnetic switch. After applying heat insulation to the tank, the whole installation was located at a strategic point for its most efficient use. The total cost of all the electrical equipment was approximately $85. The only other expense was the cost of the tank, insulating it, installing it, and providing a dust-tight compartment for the control equipment. It is entirely automatic, the operator merely adjusting the flow of water to meet the requirements. In a flour mill, cleanliness is paramount, economy of operation is vital, and low cost of equipment is a necessity.

This 30-gal., 15-kw installation will temper up to 600 bushels of wheat per hour (supply water about 70 deg. Fahr. and add 3 per cent moisture by weight to the wheat) and therefore is adequate for the average size mill. Larger mills would require a duplicate installation or a larger single tank with a greater connected load. The former might be preferred from the standpoint of flexibility of operation.

An idea of the power consumption may be gained from the following:

100 gal. of 120 deg. Fahr. water is required for adding 3 per cent moisture (by weight) to 450 bushels of wheat in the tempering process.

100 gal. of water per hour raised from 70 deg. Fahr. to 120 deg. Fahr. requires about 12 kwhr.

And remember this; once a miller becomes accustomed to the niceties of electric heat with its convenient automatic control, he is going to be awfully tempted to use it the year around.

UNLOADING MEXICAN ASPHALT WITH THE AID OF ELECTRIC HEAT

Mexican asphalt, which has a melting point of 225 deg. Fahr., has long been a source of trouble to the roofing industry, particularly from the standpoint of unloading if shipped in liquid form and in tank cars. When loaded into the car, it has a temperature of 450 deg. Fahr. to 600 deg. Fahr. However, during the time that it is in transit, a portion of the asphalt cools, settles to the bottom, and forms a hard layer. Since the valve through which it must be pumped off is located in the bottom of the car, this cold layer makes it impossible to start a flow through the valve.

All tank cars used for this purpose are equipped with steam coils, but with these it is a slow process, unless superheated steam is used, to get this valve working. Several methods of heating this cold layer have been successfully worked out, but most of these have the disadvantage of being very expensive, both from the standpoint of installation and operation. For instance, in a certain plant a hot oil heating installation would have cost $14,000 plus the cost of buildings and erection.

For the above reasons, the McHenry-Millhouse Mfg. Co., manufacturers of a high grade of roofing material, have in the past bought this type of asphalt in cold form. This makes freight rates, handling costs, heating costs, and original costs of asphalt much higher.

In November, 1932, it was decided to try to do this job with electric heat. For this purpose, three 4 kw units, similar to those designed for oil and salt baths, were selected. Each of these was mounted on the end of 10 ft. of 1 in. conduit, on the opposite end of which was arranged a heavy-duty plug. Another set of plugs was arranged on the side of the pump house. Connections were made between these two points with rubber-covered flexible cord.

When a car of asphalt arrives and is placed on the siding, the man-hole cover is removed, the three 4 kw units inserted through the opening and placed as nearly as possible to the valve opening. Also steam connections are made so as to melt any asphalt that might otherwise cling to the steam coils. In the course of one or two hours the asphalt surrounding the valve opening is thoroughly melted so that when the valve

is opened, there is no trouble in getting the asphalt to the pump. During the time that the material is being pumped from the car, the units remain in operation to break up any lumps that might otherwise flow to the valve and stop the flow. This operation usually requires from 8 to 12 hr. It must be understood that no effort is made to heat the enormous mass of asphalt contained in the car. The function of these units is simply to keep the valve open.

This complete equipment cost considerably less than $1,000 installed, and from an operating standpoint is very economical. It is estimated by the officials of the plant that this equipment saves them approximately $100 per car. So far, about 40 cars have been unloaded with this equipment, so it is safe to estimate that it has paid for itself four times to date.

Needless to say, the customer is very well satisfied.

MAY ELECTRIC REFRIGERATOR SALES

(*Continued from page* 102)

registered 23,284 sales, compared to 11,839 in April and 13,429 in May, 1932. In Massachusetts the May total was 11,531, as against 6588 in April and 5957 in May a year ago. North Carolina showed a jump to 5061 units from 2349 in April. In May, 1932, the total was 1009. Louisiana, Rhode Island, Nebraska and Wyoming are other States which approximately doubled their April totals and surpassed their sales of May, 1932, by even wider margins. As usual, New York led the procession in total sales with 31,035. This figure compares with 19,559 in April and 27,606 in May, 1932.

Many opinions have been advanced as to the exact causes of this unprecedented sales increase at this time. Doubtless a large number of factors affected the result, but among the most important was the pronounced increase in cooperative activity through local Bureaus and other local cooperative organizations which adopted Electric Refrigeration Bureau methods. Moreover, this tremendous gain in public acceptance would seem to bear out the forecast made by one of the country's largest appliance sales organizations early last Winter, when a country-wide survey of all of its thousands of employees revealed that the vast majority named an electric refrigerator as its first choice in a major household purchase, when there should be sufficient improvement in general business conditions and personal confidence to warrant it.

$1,200 IN PRIZES FOR REFRIGERATION WEEK

Prizes aggregating approximately $1,200 will be offered to local Bureaus next fall by the Electric Refrigeration Bureau as one of the features of Electric Refrigeration Week. This plan of activity, submitted by the Bureau's Plan Committee, is embodied in an announcement by Executive Chairman James E. Davidson, covering the Bureau's program for the balance of the year.

"In unanimously adopting the suggestion," says Mr. Davidson, "the Plan Committee felt that the prize offering would result in a pronounced stimulation of interest in this year's celebration of Refrigeration Week. A budget to cover the promotional expenses of the contest was therefore approved.

"The contest plan involves the awarding of prizes for the best cooperative electric refrigeration shows put on by local bureaus. Population and the number of domestic meters in each participating community, the amount spent in each instance on the exhibit and general promotion work, the degree to which sales outlets cooperate and, finally, the results in actual refrigerator sales and in prospects obtained, will be considered in judging the contest. With details of the contest worked out along these general lines it will be possible for any community to win, regardless of its size.

"It is proposed to offer a first prize of $500, with six lesser awards scaled down in amounts ranging from $250 to $25. Three broadside folders will be issued by the Bureau. The first, to be distributed about Aug. 25, will call the attention of all local Bureaus to Electric Refrigeration Week, outline the contest and list promotional materials available. The second, out about Sept. 5, will offer definite suggestions for putting on cooperative shows, while the third, to be issued about a week later, will carry the final message from the home office in the form of a resume of the suggestions previously advanced.

"In planning the annual Christmas activity, the committee discussed several new suggestions, but finally discarded them all and decided on a Holiday Window and Floor Display Contest, notwithstanding the fact that the Bureau has operated similar contests in the past. The manufacturers' representatives on the committee were strongly in favor of this contest, holding that it not only creates a large amount of interest among dealers and central stations, but offers themselves an excellent opportunity to tie in with it in their own seasonal sales campaigns.

"The committee also authorized the preparation of a series of six new newspaper advertisements for distribution about Sept. 1, and another series of three to be ready about Nov. 1, and adopted a schedule of fall trade-paper advertising.

"Every present indication points to a most successful year of Electric Refrigeration Bureau activity. The pronounced increase in sales, starting in April and mounting to record proportions in May and June, has produced confidence and optimism in every branch of the industry. This feeling received marked stimulation from the large number of spring shows, and has been reflected in the unprecedented attendance at the refrigeration meetings held in various sections of the country. I am confident that we will reach our national quota for the year."

KANSAS ANTI-UTILITY MERCHANDISING LAW UNCONSTITUTIONAL

By a vote of 5 to 2, the Kansas Supreme Court held the Kansas anti-merchandising law unconstitutional. The decision was in a case brought by the Cities Service Gas distributing companies operating in Kansas which contested the law passed by the 1931 Legislature of that State. It will be recalled that the lower court upheld the law, but on appeal to the Supreme Court the decision was reversed.

In brief the opinion states:

"In the opinion written by Justice William Easton Hutchinson, it was held: 'That where a public utility corporation is authorized to do business in Kansas in the manufacture, purchase, supply and distribution of artificial and natural gas, the sale of gas appliances by it, under the facts and circumstances set out in this opinion, is intimately connected with and incidental to the same distribution of gas, and is an implied power of such company because it directly and approximately tends to accomplish the general purpose for which the company was incorporated.'

"Relative to the unconstitutionality of the law the decision said: 'Chapter 238 of the sessions laws of 1931 is unconstitutional and void because it is in violation of the fourteenth amendment of the constitution of the United States in that it denies to certain individuals, firms and corporations the equal protection of the law.' * * * *

"The court held that there was evidence to show that 80 to 90 per cent of the gas appliance fixtures were sold by the utility companies and that they sold and installed safe and standard equipment at fair and reasonable prices and at a fair profit. Long term contracts permit consumers to enjoy use of modern equipment and campaigns of the utilities companies went far in increasing the demand for their service. These activities, it was held by the court, were regular, legitimate, and within the constitutional rights of the corporations.

"In conclusion the court in its prevailing opinion said: 'With no feature of public welfare actually involved, the conclusion surely must follow that to deprive these plaintiffs of an implied power and privilege incidental to their general business is unreasonable, arbitrary, unjust and oppressive. Other individuals, firms and corporations can engage in merchandising these appliances, but this particular class cannot. They are deprived the equal protection of the law. We therefore conclude that the act is unconstitutional as being in violation of the fourteenth amendment of the constitution of the United States.'"

POWER SALES ITEMS

AIR CONDITIONING

"Air Conditioning in Modern Brewery," L. L. Simmons. Heating, Piping and Air Conditioning, May, 1933, pp. 245-6. Engineering Publications, Inc., 1900 Prairie Avenue, Chicago, Ill.

Application of new methods of cooling and ventilation for comfort and business; use of unit coolers; exhausting carbon dioxide gas; need of bacteria-free-air; close control of yeast storage; malting grain; increased need for air conditioning.

"Energy Requirements for Air Conditioning of Homes," D. W. McLenegan, Electrical World, May 20, 1933, pp. 644-7. McGraw-Hill Publishing Co., 330 West Forty-second Street, New York City.

Paper presents data relating to following questions, based on climatic conditions in various parts of country; size and type of equipment needed to condition air of average home; how long operating seasons are for this equipment; must electric utilities enlarge service facilities to care for added load; does this load combine favorably with other domestic electric loads; Before American Institute of Electrical Engineers.

"Air Conditioning Equipment." American Architect, May, 1933, pp. 89-94 International Publications, Inc., Fifty-seventh Street and Eighth Avenue, New York City.

Three factors in comfort; factors contributing to health; objectives of air conditioning; engineering considerations involved; basic types of equipment employed; methods of producing air motion; methods of cleaning air; methods of humidification; methods of dehumidifying air; methods of cooling; combination devices; automatic controls; effect of air conditioning on building design.

"Comfort Cooling for Stores," W. L. Fleisher. Architectural Forum, May, 1933, pp. 409-12. Rogers & Manson Corp., Publisher, 220 East Forty-second Street, New York City.

Review of special store problems; cooling load; comfort conditions; cooling methods refrigeration; initial and operating costs.

"Cooling With Ice," E. Brandt. Heating & Piping Contractors National Association—Official Bulletin, June, 1933, pp. 38-40. Heating & Piping Contractors National Association, 50 Union Square, New York City.

Uses of ice in summer air conditioning and comfort cooling; describes systems, coolers, sources of refrigeration, ice, cooling cycle, temperature control, melting demands, ratings, seasonal demands, economy of operation and maintenance.

DIESEL ENGINES

"Keighley Industrial Diesel Engine." Gas & Oil Power, April, 1933, pp. 108-9, 426-7A, Grand Bldg., Trafalgar, London W. C. 2, England.

Principal features of new compact low power totally-enclosed engine introduced by Beechey, Lund & Co.

"New Castle Completes New Diesel Station." Power Plant Engineering, May, 1933, p. 221. Technical Publishing Co., Monadnock Block, 53 W. Jackson Boulevard, Chicago, Ill.

Extensive changes in its municipal light and water plant in order to handle its growing street lighting and pumping loads; two generating units installed; smaller is 500 hp., 4 cyl. engine, direct connected to 345 kw., 0.8 pf. generator and 10 kw. exciter; larger is 750 hp., 6 cyl. engine direct connected to 518 kw., 0.8 pf. generator and 15 kw. exciter.

ELECTRIC DRIVE

"Electrification of Large Steel Mill." Mechanical World, April 28, 1933, pp. 409-11. Mechanical World, 31 King Street West, Manchester 3, England.

Details concerning replacement of steam-engine drive by efficient electric reversing drive in slabbing and blooming mill at Dalzell Works of Colvilles, Ltd.; motor has speed range from 0-60 r.p.m., and further speed range at constant horsepower of 19,000 from 60-150 r.p.m.; equipment and flexibility of mill; transmission; electric drive.

"Cotton Mill Change-over," G. T. Allcock. Electrical Review, May 19, 1933, pp. 695-7. Electrical Review, Ltd., 4 Ludgate Hill, London E. C. 4, England.

Results obtained by electrification at Messrs. Ashton Bros. & Co., Ltd., cotton manufacturers at Hyde; electrical equipment and distribution of new material.

ELECTRIC FURNACES

"Experience of Gray Iron Jobbing Foundry with Rocking-Type Electric Furnace," C. R. Culling. American Foundrymen's Assn.—Advance Paper, No. 33-6, meeting June 20-3, 1933, 16 pp. American Foundrymen's Assn., 222 West Adams Street, Chicago, Ill.

Applications of rocking-type electric furnace for production of wide variety of castings to meet requirements encountered in general jobbing field; possibility of manufacturing product having greatly improved qualities; establishment of definite control over quality; flexibility of rocking electric furnace; possibility of increased service to consumers.

"Gray Iron Production in Direct-Arc Acid-Lined Electric Furnace," C. L. Frear. American Foundrymen's Assn.—Advance Paper No. 33-1, Meeting June 20-3, 1933, 24 pp. American Foundrymen's Assn., 222 West Adams St., Chicago, Ill.

Method of melting gray cast iron in direct-arc acid-lined electric furnace; description of different operations desirable or necessary to produce soft, easily machinable, but close-grained castings, even using very large amount of steel and cast-iron scrap, including chips and borings, and correspondingly small amount of pig iron in charge.

"Low Temperature Heat-Treatment Furnace." Mechanical World, May 5, 1933, pp. 431-2. Mechanical World, 31 King Street West, Manchester 3, England.

New resistance furnace made by Birmingham Electric Furnaces, Ltd., designed to introduce precision into low-temperature heat-treatment methods; centrifugal fan circulates air through work and over heating elements at pressure high enough to overcome fluid resistance through closely packed work; work basket is screened from radiant heat and accurate system of temperature control is employed.

GAS ENGINES

"Gas Engines and Compressors, W. L. Russell. Power, April, 1933, pp. 195-6. McGraw-Hill Publishing Co., 330 West Forty-second Street, New York City.

Studies have shown that with 30-cent gas and 10-hr., 100 per cent load factor, the cost is about one cent per kilowatt-hour for electricity generation by the gas engine. This compares with the Diesel on the same load factor using 4.8 cent oil per gallon. Since unlimited reserves of natural gas are claimed available, and it is now being distributed in about 25 States, the operating advantages of the gas engine assume considerable importance.

GAS ENGINES—COST

Gas-Engine Costs Installed 80 Miles from Los Angeles—June 5, 1933.

Buda gas engine, 40 hp., cost $2,300, including gear and interest. Three payments of $110 each in 1933. Five payments of $110 annually till paid out. Buda 30 hp., $1,800, includes gear and interest, 12 payments of $50 a year plus interest at 5 per cent.

PUMPING PLANTS

"Chicago to Build 300-M.G.D. Pumping Plant," L. D. Gayton. Engineering News-Record, June 8, 1933, pp. 752-4. McGraw-Hill Publishing Co., 330 West Forty-second Street, New York City.

Main features of New Harrison Street station which will replace three existing stations that have become obsolete; pumps are to be driven by electric motors; annual saving in operating cost to be $225,000.

STEAM POWER PLANTS

"That Will-o-the-wisp, Ultimate B.T.U.," A. D. Bailey. Electric Light and Power, June, 1933, pp. 26-9. Bennett-Watts-Haywood Co., Publisher, 360 North Michigan Avenue, Chicago, Ill.

Centralization of steam-generated electric production and improvements in design of equipment and structures have resulted in continuous decrease in cost of steam stations per unit of capacity; high-pressure steam plants have given good account of themselves; progress in flue-gas analysis and smoke abatement.

SURPLUS POWER

"Surplus Power—Availability, Cost and Economic Disposal," A. G. Christie, Professor of Mechanical Engineering, Johns Hopkins University, Baltimore, Md. Power Plant Engineering, May, 1933, pp. 203-4. Technical Publishing Co., Monadnock Block, 53 West Jackson Boulevard, Chicago, Ill.

REVIEWS

COMMITTEE REPORTS

The Operating Committee of the Institute has authorized the publication of approximately twenty reports prepared by committees of the former National Electric Light Association during the last months of its existence, and turned over to the Institute by the Liquidating Committee of the N. E. L. A.

Five of these reports have been published and placed on sale. These reports are: Power Station Chemistry; Burning of Liquid and Gaseous Fuels; A. C. Networks Operation; Fault Locating Methods Used on Underground Cable Systems; and Power System Wave Shape. Brief reviews of the above reports appear in this issue.

Four reports of the former Prime Movers Committee are now at the printers and will be published early in August. These reports are Turbines; Station Piping; Pulverized Fuel; and Stoker Equipment and Furnaces. Cable Operation, a report of the Underground Systems Committee, will be published about the same time.

Other engineering reports scheduled to appear about the first of August include Current Carrying Capacity of Impregnated Paper, etc.; Load Area Development; and Load and Revenue Forecasting.

Commercial reports to be published during the summer include a report on Home Air Conditioning; one on Marketing Electricity for Commercial Kitchens; and reports of the former Lamp Committee and the former Commercial Cooking Committee.

Reviews and prices of these reports will appear in the August issue of the BULLETIN.

In addition to the foregoing there will be published in early issues of the BULLETIN reports on Power System Interconnection; Foreign Practice on Insulating Oils in Transformers; Hydrogen Cooled and Outdoor Air-Cooled Rotating Machinery; Foreign Practice on Arcing Ground Suppressors; and Suggested Standard Packages.

POWER STATION CHEMISTRY

Report of former Prime Movers Committee, published by Edison Electric Institute, Pub. No. A-5. Price 40c. to members and their employees; $1.00 to non-members; $1.10 to foreign countries.

This report considers the following subjects as they pertain to power station practice:

1. Methods of water analysis.
2. Slag accumulation in boiler furnaces.
3. Electrolytic prevention of scale and corrosion in boilers.
4. Chlorination of circulating water.
5. Phosphate for boiler water treatment.

BURNING OF LIQUID AND GASEOUS FUELS

Report of former Prime Movers Committee, published by Edison Electric Institute. Pub. No. A-4. Price, 30c. to members and their employees; 75c. to non-members; 85c. to foreign countries.

This report includes data on the following:

1. Rates of furnace heat liberation.
2. Excess air.
3. Gas metering.
4. Comparison of operation of solid fuel furnaces after conversion to oil or gas.
5. Comparison of operation of gas-and oil-fired boilers.
6. Deterioration of fuel oil in storage.
7. Automatic combustion control.
8. Explosions in settings and breechings.
9. Time for firing cold boilers.

This report has been prepared from information supplied by operating companies and manufacturers, and excerpts from their statements are included.

POWER SYSTEM WAVE SHAPE

Report of former Foreign Systems Coordination Committee, published by Edison Electric Institute. Pub. No. A-13. Price, 20c. to members and their employees; 50c. to non-members; 60c. to foreign countries.

The wave shape of power systems from the standpoint of inductive influence of noise frequency on communication circuits is considered in this report, which is presented in three sections.

In Section I, attention is directed to the characteristics of power systems which affect wave shape. The sine wave is found in practice to be modified by the presence of harmonics. Various elements producing harmonics, discussed in this report, are: rotating machinery, transformer exciting current connections of transformers banks, connections of generator neutrals, mercury arc rectifiers, and corona.

A survey, for the purpose of providing data for use in problems of inductive coordination at noise frequencies, was conducted over a period from 1927 to 1929. A summary of the results of this survey are presented in Section II of this report. Observations were made on transmission circuits operating at voltages between 11 kv. and 132 kv. The majority of distribution feeders tested were three-phase, three-wire at 2.3 kv., or three-phase, four-wire at 4 kv. Wave shape measurements were made on generators, motor generator sets, and synchronous converters.

In Section III, the two methods commonly used for the determination of wave shape are described. These methods involve the use of the harmonic analyzer and the Telephone Interference Factor Set. A diagram is presented showing a typical set-up of measuring equipment.

A. C. NETWORKS OPERATION

Report of former Underground Systems Committee, published by Edison Electric Institute. Pub. No. A-9. Price, 20c. to members and their employees; 50c. to non-members; 60c. to foreign countries.

This A. C. Networks Operation report is a summary of the data obtained from a large number of companies operating A. C. Networks. This report shows the extent, type and size of all of the principal A. C. Networks in the United States and many of those in foreign countries.

FAULT LOCATING METHODS USED ON UNDERGROUND CABLE SYSTEMS

Report of former Underground Systems Committee, published by Edison Electric Institute. Pub. No. A-13. Price, 40c. to members and their employees; $1.00 to non-members; $1.10 to foreign countries.

In the operation of an Underground System, one of the most important factors is the prompt location of faults on the cable system. This report shows the method used by the companies operating the larger cable systems. It shows the latest development in the location of faults.

PUBLIC UTILITY RATE STRUCTURES

By L. R. Nash, Public Utility Consultant, McGraw-Hill Book Co., Inc., New York, N. Y., $4.

This book is an excellent presentation of the entire subject of rate procedure in which even the layman can get, simply and clearly, the thought of an experienced designer of rates.

As the author states in the introduction "A basic purpose of this book is to portray rate making not as an exact, scientific procedure but as a skillful balancing of conflicting objectives, a curbing of tendencies toward technical complications, and an avoidance of undue yielding to the public urge for the simplicity prevailing in other commercial transactions."

At the end of each chapter references are given to supplementary literature which has a distinctive merit and substantiates some of the principles outlined in the text, making it that much more valuable as a reference book through which a particular subject may be further perused. A chapter on cost analysis clarifies many of the controversial questions which apply to this particular feature of rate making.

The author's earlier book "Economics of Public Utilities" deals particularly with the phases of regulatory procedure, valuation, depreciation and accounting methods, which are a necessary consideration in rate making, so that this later book "Public Utility Rate Structures" may be classed as a supplementary discussion of the questions which are essential for a proper and a scientific background in utility procedure.

F. W. H.

OUTAGES, SERVICE STANDARDS AND INVESTMENT

(*Continued from page* 126)

methods outlined in this paper are pursued, the cost of facilities for reliability would be evident and the query as to whether or not the result is worth what it costs will be raised before the project is undertaken in the form of added dollars per kilowatt of firm capacity.

I heartily endorse what Mr. Huff has to say concerning the large sums which may be spent under the guise of improving the reliability or quality of service without determining whether or not the improvement is justified by the service requirements and what it will cost to get it. The question of voltage regulation and lamp flicker can be further studied with decided profit.

I cannot agree with Mr. Huff's statement that expenditures for load growth are usually obvious. Whether or not the facilities in any particular situation are overloaded is a matter of the firm rating of the equipment and that turns upon the reliability assumptions made, the firm capacity being the name plate rating less the reliability reserve. It is, therefore, necessary to settle the question of reliability reserve before one can really tell whether or not existing facilities are overloaded. There is only one way to settle the question of reliability and that is to go back to the actual operating record for lines, station, and equipment.

Referring to Mr. DeMerit's discussion:

The stress which Mr. DeMerit has laid upon the importance of the task of the distribution engineers and the necessity for adequately trained personnel to supervise distribution work is very much to the point. As a result of studies like those which Mr. DeMerit has made, the distribution transformers and secondary mains are receiving the attention which they deserve as a major investment item.

Referring to Mr. Silver's discussion:

Mr. Silver's definition of outage in kilowatthours loss of service to customers as well as the product of number and duration of outages per customer is very interesting. At one time we made an effort to set up such kilowatthour figures but found it very difficult to do so with any result of accuracy. Furthermore, the kilowatthour index has a different meaning for different classes of customers. For instance, one might consider it more important to avoid the loss of a hundred kilowatthours of service to residential customers than to avoid the same amount of outage to a large industrial concern. We, therefore, went back to the "number and duration per customer" method.

In considering ways and means of improving the reliability of existing lines we have been hesitant about adding any moving parts or devices to the simple distribution transformer largely from the maintenance point of view, feeling that troubles arising on an overhead secondary system were not sufficiently frequent to justify the complication. We are also inclined to give a thorough tryout to the better grade of lightning protection which is made available when a common secondary neutral and lightning arrester ground is employed before adding any complications to our transformer primary fuses. It is not difficult to get one's self into more trouble than one gets out of when complication is added to a multiplicity of small devices scattered over a large system.

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CONVENTIONS AND MEETINGS

JULY

1 American Society of Civil Engineers, Chicago, Ill.
1-10 World Power Conference, Sectional Meeting, Stockholm, Sweden.

AUGUST

28-31 Illuminating Engineering Society, Delevan, Wis.

SEPTEMBER

4-8 American Institute of Electrical Engineers, Pacific Coast Meeting, Salt Lake City, Utah.
6-8 Pennsylvania Electric Association, Bedford Springs, Pa.
11-15 International Association of Electrical Inspectors, Chicago, Ill.
18-20 American Transit Association, The Stevens Hotel, Chicago, Ill.
20-30 National Electrical Exposition, New York, N. Y.
25-29 American Gas Association, Chicago, Ill.

OCTOBER

2-6 National Safety Council Congress, The Stevens Hotel, Chicago, Ill.
10-13 National Association of Railroad and Utilities Commissioners, Cincinnati, Ohio.
15-19 National Electrical Contractors Association, Indianapolis, Ind.
17-19 Association of Iron and Steel Electrical Engineers, Pittsburgh, Pa.

LIGHTING FIELDS TO EXPLORE WITH PROFIT

(*Continued from page* 106)

I have purposely centered upon the residence field because this seems to be the one in which the problems are most difficult. We have already had called to our attention, through the trade press and through industry committee meetings, the sales technique developed by the American Gas & Electric Company, which applied these same principles to the commercial field. The results of these operations have been given wide publicity and I feel that it is not necessary for me to repeat them here. As to the industrial field, is there any reason why these same principles cannot be applied with equal effectiveness?

We all face new problems in this old field of lighting but we have new tools with which to work. New equipment which, because of its portability and flexibility and the dramatic way in which it registers lighting intensity, make it possible to demonstrate the benefits of adequate lighting and in a most dramatic way.

We have new tools of salesmanship consisting of a more forceful approach and a more compelling appeal with which to persuade our customers to use more of our service. Those who have faced the facts in regard to their lighting load and have determined to do something about it are getting results. They are pegging decreased consumption and, in spite of conditions as they have existed during the past winter, are in many cases securing increased load and consumption. Probably more important than either of these results, they are reaping a harvest of good will from customers who have sincerely appreciated the effort made to show them how to use light properly.

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